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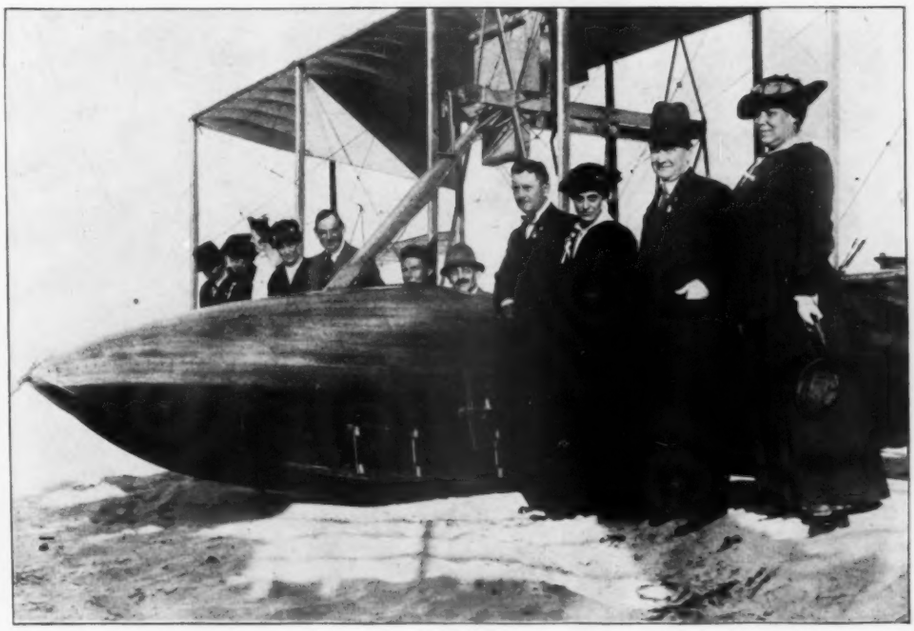
Foundrymen Spend Busy Week at Atlantic City

Many Important Subjects Discussed—Uniform Cost System Approved —Ladle Stoppers Will Be Standardized—Attendance Breaks Record

FROM every standpoint, the 1915 foundry convention, which was held at Atlantic City during the last week in September, was a record-breaker. The official registration of the members and guests of the American Foundrymen's Association and the American Institute of Metals reached a new high figure, 884. In addition, thousands of foundrymen and visitors, not members of the allied organizations attended and were registered by the Exhibition Co. In volume, interest and value, the proceedings fully measured up to the high standard set by previous conventions; a total of 64 papers and reports were presented, 39 at the meetings of the American Foundrymen's Association and 25 at the session of the American Institute of Metals. The discussions were lively and instructive, and the large number of committee reports indicated great activity in the foundry industry along many lines of scientific and practical endeavor. The unusual recreation and hotel facilities of Atlantic City contributed to the success of the occasion.



INTERLUDES BETWEEN PROFESSIONAL SESSIONS OFFERED OPPORTUNITIES FOR AVIATION

The tenth annual Foundry and Machine Exhibition, conducted under the auspices of the Exhibition Co., surpassed expectations in the number and character of the displays. Practically all of the exhibitors, also, were rewarded by liberal sales, reflecting the quality as well as the numerical strength of the attendance. A complete description of the exhibits appears elsewhere in this issue. The exhibition opened Saturday morning, Sept. 25, and closed Friday evening, Oct. 1. The conventions, which opened with a joint session Tuesday, Sept. 28, concluded their deliberations also on Oct. 1. During the week the American Foundrymen's Association held seven and the Institute of Metals six professional sessions, including the joint meeting on Tuesday. The evenings, with the exception of Wednesday, when the annual business session of the American Foundrymen's Association took place, were devoted to entertainment and recreation.

In the paragraphs that immediately follow, the proceedings of the American Foundrymen's Association

THREE PRESIDENTS ON THE ROSTRUM

From left to right: G. H. Clamer, president, American Institute of Metals; R. A. Bull, president, American Foundrymen's Association and W. H. Barr, president, National Founders Association

are presented in considerable detail, and at the conclusion of this report will be found an equally complete account of the sessions of the Institute of Metals.

With the officers of both associations presiding, the opening joint session was held in the beautifully decorated Greek Temple on Young's Million Dollar Pier. The attendance was unusually gratifying. R. A. Bull, president of the American Foundrymen's Association, acted as chairman. Henry A. Carpenter, General Fire Extinguisher Co., Providence, R. I., a vice president of the American Foundrymen's Association, delivered the address of welcome on behalf of the local committee of eastern foundrymen, of which he was a member. Mr. Carpenter commented on the prosperous condition of the foundry industry and expressed the opinion that 1916 would prove a banner year. Pig iron prices, he explained, are ascending and the foundry industry always enjoys prosperity when pig iron is high. He also commented upon the recent advances in the world of science, including transcontinental telephony, which has now become an established fact. He pointed out that organizations such as the American Foundrymen's Association and the American Institute of Metals are as helpful in binding the business community together as the wonderful means of communication which we now have at hand.

J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill., also one of the vice presidents of the American Foundrymen's Association, responded to the address of welcome in an appropriate manner.

Major Joseph T. Speer, Pittsburgh Valve, Foundry & Construction Co., Pittsburgh, past president of the A. F. A., moved the appointment of a committee to draft appropriate resolutions on the deaths of Thomas D. West and E. H. Mumford. He suggested that the committee consist of Dr. Richard Moldenke, chairman; Thomas Devlin, Philadelphia, and Paul Kreutzpointner, Altoona, Pa. Major Speer's motion was passed unanimously.

Report of Safety Committee

The convention then turned to the technical portion of the program, which was opened with the report of the A. F. A. committee on safety and sanitation. In the absence of A. W. Gregg, Bucyrus Co., South Milwaukee, Wis., chairman of the committee, the report was presented by the secretary. It suggested that the American Foundrymen's Association issue occasional safety bulletins and also recommended the publication of a special bulletin in memory of Thomas D. West, whose colossal work on safety and sanitation will always remain a landmark in foundry history.

Modern Industrial Education

Prof. Frank M. Leavitt, University of Chicago, presented the report of the committee on industrial education. Prof. Leavitt spoke extemporaneously, emphasizing the need for closer co-operation between business men and school boards in order that suitable industrial training may be provided in the public schools for those in the humbler walks of life, as well as for leaders.

The committee's suggestions developed considerable discussion. Major Joseph T. Speer outlined the work of Carnegie Institute, Pittsburgh, in industrial education with particular reference to the institute's foundry courses. J. S. Seaman, Seaman-Sleeth Co., Pittsburgh, told how industrial education had assisted one of the young men in his employ to rise from a position of laborer to chemist in a comparatively short time. During the time he was attending school this young man worked all day in the foundry, then walked about three miles to his home and after supper walked five miles further to the institute. Dr. Richard Moldenke, in referring to the specific recommendations of the committee, suggested that the best results cannot be expected unless the school men are given a definite program of industrial education by the business interests. Benjamin D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland, described the work of the technical high schools of Cleveland and also stated that it is the plan of the board of education eventually to separate pupils, according to vocations, beginning with the sixth grade. W. H. Barr, Lumen Bearing Co., Buffalo, president of the National Founders' Association, outlined the work of the conference board on the training of apprentices and extended an invitation to the allied foundry organizations to co-operate in this work.

R. A. BULL,
President, A. F. A., Hurrying to an Afternoon Session

"Tests of Lenses for Foundry Goggles" was the title of an exceedingly interesting paper presented by F. W. King, Julius King Optical Co., New York.

The paper included a copy of the recent laboratory standard for the examination and testing of goggles with plain uncolored lenses developed by the Underwriters' Laboratories, Inc., Chicago, under the direction of the National Board of Underwriters. Mr. King's address was accompanied by a demonstration of the lens testing machine and a colored spectroscopic lantern test showing, scientifically, colors of lenses used in dangerous conditions of light and glare. Various types of goggles were exhibited and explained, including colored glasses designed to exclude the ultra-violet rays given off by incandescent metal and by the electric arc.

Sand Binders Classified

A paper by H. M. Lane, foundry engineer, Trussed Concrete building, Detroit, entitled "Functions of Sand Binders", was read in abstract. After explaining the purpose of sand binders in foundry operations, this paper presents a classification of such binders, dividing them into soluble binders, paste binders, colloids and allied bodies, including gums, pitches and oils. It is pointed out that the first two classes are subject to moisture, but the colloid bodies may or may not be subject to injury from moisture, while the gums and pitches, as a rule, are water-resisting or waterproof. The paper discusses the binding power of these various materials in detail and included much valuable information on the adaptability of binders for cores for various classes of work.

A preliminary report on molding sands was presented by C. P. Karr, associate physicist, bureau of standards, Washington, D. C.

This report evoked considerable discussion, which was opened by Dr. Moldenke, who suggested that the bureau of standards examine the previous work of the American Foundrymen's Associa-

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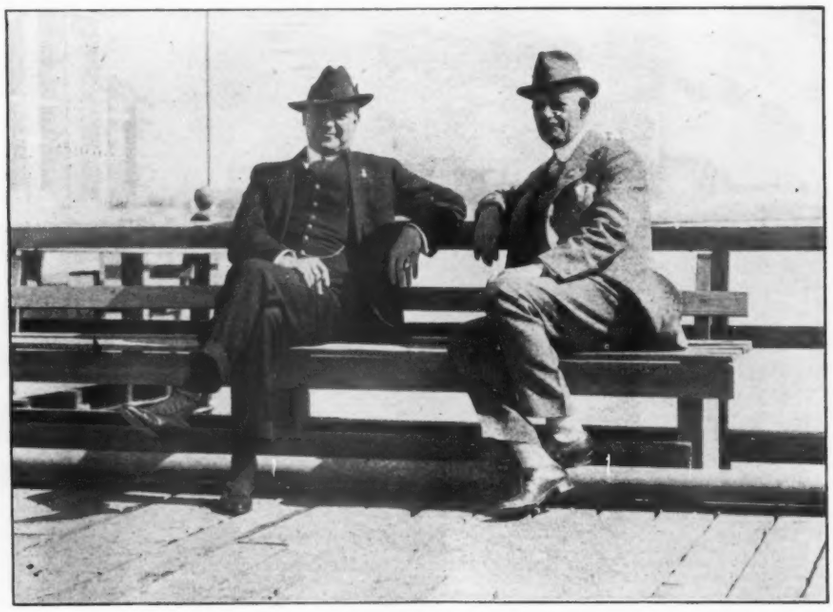
tion on molding sands. In this connection Dr. Moldenke graciously offered to contribute numerous samples of sands in his possession to the bureau for its experimental work. H. E. Field, president, Wheeling Mold & Foundry Co., Wheeling, W. Va., referred to Dr. Moldenke's exhaustive work on molding sands and suggested that the American Foundrymen's Association should arrange to co-operate actively with the bureau of standards in the investigation which it is undertaking. W. M. Corse, Titanium Alloy Mfg. Co., Niagara Falls, secretary of the Institute of Metals, explained the work of a committee representing various national technical societies which meets with the bureau of standards twice a year for the consideration of suitable lines of investigation. Mr. Corse recommended that the American Foundrymen's Association should join with the activities of this committee. Mr. Field backed up this suggestion by moving the appointment of a committee to co-operate with the bureau of standards, suggesting that Dr. Richard Moldenke be the chairman. This motion was passed unanimously and President Bull accorded Dr. Moldenke the privilege of naming his own committee.



EAST GREETS WEST

J. P. Pero, Missouri Malleable Iron Co., East St. Louis, on the right, with Henry A. Carpenter, General Fire Extinguisher Co., Providence, R. I.—Both Vice Presidents of the A. F. A.

A paper on "Albany Molding Sand", by D. H. Newland, associate state geologist, Albany, N. Y., was presented.

This paper was accompanied by interesting lantern slides, showing methods of extracting, grading and shipping Albany sand, together with micro-photographs showing the characteristics of the sand in detail.

R. F. Harrington, Hunt-Spiller Mfg. Co., Boston, opened a discussion by asking if the producers could not adopt some method of grading the sand more accurately. It was the sense of the meeting that progress could be made in this direction and considerable discussion of the dye bond test ensued. It was pointed out that the bond test is particularly useful in controlling the quality of heap sand, to be sure that it will at all times be in condition to produce the highest grade of castings. When the bond test shows that the sand is wearing out, economic considerations must determine whether it is best to attempt to restore the old sand by adding clay, etc., or to throw the old sand away and replace it with new material. This paper also was discussed briefly by J. J. Wilson, Cadillac Motor Car Co., Detroit, and by E. M. Ayers, of the Interstate Sand Co., Zanesville, O.

R. A. Bull, manager of production, Commonwealth Steel Co., Granite City, Ill., presented a paper entitled "Notes on Applications and Characteristics of Cores in Modern Molding". Mr. Bull defined the term "core" and discussed the use of cores in molding operations at considerable length.

At the conclusion of the Tuesday morning session the nominating committee and committee on resolutions were appointed. The former consisted of J. S. Seaman, chairman, Joseph T. Speer, L. L. Anthes, Alfred E. Howell and Henry A. Carpenter. The resolutions committee included Benjamin D. Fuller, chairman, Joseph J. Wilson and W. D. Robinson.

The Tuesday afternoon session was characterized by several excellent papers on molding machine practice and scientific management. "Patternmaking for Molding Machine Work", was presented by E. I. Chase, Cadillac Motor Car Co., Detroit.

E. S. Carman, Osborn Mfg. Co., Cleveland, presented a large number of lantern slides with his paper on "Foundations for Jar-Ramming Molding Machines". The slides showed the construction and characteristics of various foundations in detail. This paper is published elsewhere in this issue.

In discussing the paper, S. D. Sleeth, Westinghouse Air Brake Co., Wilmerding, Pa., stated that he had observed difficulties, occasionally, on account of ground vibration, which shook out molds 30 feet or more away from the jarring machine. In order to eliminate this vibration it was necessary to extend the foundation down to gravel at a depth of 12 feet. The author replied that ground vibrations can be eliminated if the machine is constructed to properly cushion the blows.

An exhaustive paper on "The History and Development of the Molding Machine with Sidelights on Latter-Day Practice", by J. J. Wilson, Cadillac Motor Car Co., Detroit, and A. O. Backert, Penton Publishing Co., Cleveland, was presented by the former.

Molding Machine Practice

The paper was accompanied by 81 lantern slides, showing molding machines in great variety and in actual operation. In answer to a question, E. S. Carman explained that hydraulic molding machines are not utilized in the United States, as they are in Europe, because American foundries are provided with other sources of power, chiefly compressed air and electricity.

In a paper entitled "Scientific Management and Its Relation to the Foundry Industry", by H. K. Hathaway, Tabor Mfg. Co., Philadelphia, the purpose and accomplishments of scientific management were explained. This paper will appear in later issues of *The Foundry*.

W. M. Saunders and H. B. Hanley, consulting chemists, Providence, R. I., presented a paper on "Reclaiming Molding Sand", which discussed a method of reclamation by restoring the bond with clay.

S. V. Blair, Rushville, Ind., former president of the Associated Foundry Foremen, was not able to be present and his paper entitled "The Relation of the Foundry Foreman to His Employer", was read by the secretary. The report of the committee on specifications for foundry scrap was presented by its chairman, S. D. Sleeth, Westinghouse Air Brake Co., Wilmerding, Pa. The report was accepted and a motion passed to continue the committee for further investigation. Dr. Moldenke suggested

that the specifications should include stove plate scrap and pointed out the necessity of eliminating burnt grate bars.

At the Wednesday morning session Dr. Richard Moldenke, Watchung, N. J., read an exceedingly interesting paper covering the history of the foundry from earliest times, dealing particularly with the tremendous advances of the past 25 years. In presenting his paper, Dr. Moldenke spoke extemporaneously and suggested that the American foundries might advantageously adopt the European plan of installing several small cupolas in place of one large one. The small cupolas, he explained, enable the foundryman to run several different mixtures simultaneously, thus giving him a more accurate control of the quality of his product. Benjamin D. Fuller endorsed the suggestion.

Tendencies in the purchase and sale of pig iron for the manufacture of castings were discussed in an interesting paper by Oliver J. Abell, western editor of *The Iron Age,* Chicago.

The report of the committee on costs, which was presented by the chairman, Benjamin D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland, evoked considerable discussion. The abstract of this report follows:

The adoption of a uniform basis of figuring costs by foundrymen generally is recommended. The factors constituting this uniform basis follow:

1.—A commodity sold by a foundry is the labor of the molder and coremaker and not the material entering into the product.

2.—The material is more or less a constant, varying with market conditions.

3.—Cost of production fluctuates in proportion to pounds of output per molder.

4.—Overhead charges increase or decrease, according to pounds of output per molder.

These various factors are discussed in detail and an interesting method of figuring the overhead is presented. The work is divided into two classes, namely, slow-moving and fast-moving, and it is stated that slow-moving jobs should carry a higher percentage of overhead than fast-moving jobs. Examples are cited which prove conclusively the correctness of this theory. Simple instructions are given for arriving at the proper cost. To promote the adoption of a uniform method of keeping costs, the committee recommends that 100 foundrymen guarantee a fund by the payment of $50 each, or 50 foundrymen guarantee to pay $100 each, during the period of one year. Each of these foundrymen then would have first call on the services of a cost expert and during the year he could remain at each of their plants a sufficient time to teach the accountants the basis or theory of the system recommended. Also, it is suggested that general meetings be held in the various localities visited by the cost accountant during the year and the system then could be further explained to interest foundrymen generally in the adoption of the uniform cost theory.

DR. AND MRS. MOLDENKE ENJOYING THE BOARDWALK

VETERAN FOUNDRY SUPPLY MEN

From Left to Right:—J. S. Hibbs, J. W. Paxson Co.; John Hill, Hill-Bruner Foundry Supply Co.; W. H. Fitzpatrick, S. Obermayer Co.

In a written discussion, C. B. Segner, Domestic Engine & Pump Co., Shippensburg, Pa., stated that in his opinion the overhead charges bear a closer relation to tonnage produced than to hours of molding labor. In this system the overhead is properly proportioned between the fast and slow-moving jobs by dividing the work into two classes, placing the intricate castings in one class and the plainer work in the other. The overhead for the intricate work was stated to be $1.10 per 100 pounds, that for the plain work being 96 cents. Mr. Fuller, in commenting on Mr. Segner's discussion, stated that the Westinghouse company formerly apportioned its overhead charges to tonnage of castings produced, but since discovered that this method is incorrect. The Westinghouse company now distributes its overhead on a mixed basis according both to tonnage and labor, although the large majority of the charges are distributed according to hours of labor rather than tonnage.

The paper was also discussed by H. E. Field, Wheeling Mold & Foundry Co., Wheeling, W. Va., who suggested that the American Foundrymen's Asso-

ciation adopt the suggestion of the cost committee and employ a cost expert to assist in the establishment of a uniform cost system in the shops of its members. Upon a motion by the secretary, Mr. Field's suggestion was unanimously adopted.

An exceedingly interesting paper entitled "Organization in the Foundry of the University of Illinois Shop Laboratories", was presented by R. E. Kennedy, joint author with J. H. Hogue. This paper, which is published in full elsewhere in this issue, was accompanied by numerous lantern slides showing the equipment and methods of the University of Illinois foundry.

"Structural or Mechanical Theory of the Effect of Rust on Cast Iron, Wrought Iron and Steel", was presented by R. C. McWane, publisher, *The Fire Engineer*, and H. Y. Carson, Central Foundry Co., New York.

Corrosion Tests Unreliable

The discussion of this paper brought out the almost unanimous opinion that accelerated corrosion tests are unreliable as a measure of the rust-resisting qualities of various metals. Dr. Moldenke pointed out that cast iron pipes lose comparatively little weight by rust, stating that the greatest danger arises from the presence of stray electric currents in the ground, resulting in electrolysis. J. H. Holmgreen, Alamo Iron Works, San Antonio, Tex., asked if semi-steel has better corrosion-resisting powers than cast iron. Dr. Moldenke expressed the opinion that it has, on account of its being less porous. Bradley Stoughton, consulting metallurgical engineer, New York, said he believed the corrosion-resisting powers of cast iron are due to the skin formed on castings by the action of the sand, etc., in the mold. A. O. Backert, secretary of the American Foundrymen's Association, described tests conducted by Edgar Allen Custer, Philadelphia, on soil pipe cast in permanent molds. This pipe, owing to its thick skin, resisted corrosion better than sand cast pipe, thus bearing out Mr. Stoughton's contention. Mr. Backert suggested that an investigation of the effect of sand blasting on this skin would be interesting. Dr. Moldenke described experiments covering the effect of hot hydrofluoric acid on white malleable iron. He stated that a 1 to 30 solution had practically no effect on pieces which were immersed for three months. This paper also was discussed by R. F. Harrington, Hunt-Spiller Mfg. Co., Boston, and by Ira B. Lesh, Railway Materials Co., Chicago. Mr. Lesh pointed out that car wheel treads do not rust or corrode as rapidly as the body of the wheels.

The afternoon session, Wednesday, Sept. 29, was devoted exclusively to gray iron foundry practice. Bradley Stoughton, consulting metallurgical engineer, New York, described the interesting oil-fired cupola which he has developed.

Mr. Stoughton presented a large sectional drawing of the cupola, illustrating its construction in detail. The design, he said, includes four ignition chambers, each of which is fitted with one oil burner to which oil and air are supplied at a pressure of from 12 ounces to 5 pounds per square inch. Volume air also is supplied to the ignition chambers at a pressure of 18 ounces per square inch. Coke is used in the oil-fired cupola as in ordinary practice, except that the quantities burned are greatly reduced. The results of industrial operation seem to indicate that melting with oil is somewhat faster than melting with coke, although further experiments will be necessary to establish this fact thoroughly. The best results obtained so far indicate that hot iron may be obtained by the use of 60 pounds of coke and 7.2 gallons of oil per ton of iron melted. This amount of coke does not include the bed. In a comparative test made by Dr. Moldenke it was found that iron which, when melted with coke, contained 0.080 per cent sulphur, when melted in the oil cupola contained 0.045 per cent sulphur. Another test showed that the iron increased from 0.032 per cent sulphur to 0.045 per cent, an increase of 0.013 per cent in an oil cupola melting 50 per cent of its own scrap. Crude oil, because it is cheaper and of higher heating value than fuel oil, is preferred. It is more viscous than fuel oil, however, and must be preheated by some simple means, using steam gas or electricity.

MAJOR JOSEPH T. SPEER, PAST PRESIDENT, A. F. A.

A. F. Blackwood, Michigan Steel Castings Co., Detroit, asked the author why any coke was used in the cupola at all. He suggested that silica brick might be employed if an incandescent material were necessary. The author replied that silica brick would soften and slag together at the temperatures existing in the cupola and that the coke contributed to the efficient combustion of the oil. He also pointed out that previous experiments attempting to melt iron with oil without the use of coke had been failures. The ash question also was discussed and Mr. Stoughton explained that since only a quarter as much coke was burned as usual, the volume of slag was considerably reduced. J. H. Holmgreen, Alamo Iron Works, San Antonio, Tex., asked if there was any saving in the power required to furnish the blast. The author replied that definite data on this point were unavailable, but that the same blowers were being used as when melting entirely with coke. In reply to a question by Edward Dithridge, J. L. Mott Co., Trenton, N. J., the author stated that heats had been melted ranging from 100 per cent pig iron to 100 per cent steel scrap and that long runs were made on a mixture approximating 50 per cent pig and 50 per cent scrap. Ira B. Lesh, Railway Materials Co., Chicago, questioned the success of the heats containing nothing but steel scrap and the author admitted that difficulty was met with in melting this material. He stated that on one trial the cupola had to be shut down after melting about 1,000 pounds and on another after melting a ton, owing, however, to lining troubles, which he believed could be overcome. There was less than 2 per cent total carbon in the metal poured, when melting 100 per cent steel.

Inspection of Castings

"The Inspection of Automobile Castings", was the title of a paper submitted by C. B. Wilson, Wilson Foundry & Machine Co., Pontiac, Mich.

In reply to a question the author stated that it required about six months to properly train the inspector. Another speaker described a system of bulletins issued in his shop covering errors. The bulletin file contains a record of the experiences of the shopmen and is particularly useful to new employes. George E. Jones, Whiting Foundry Equipment Co., Harvey, Ill., described a similar bulletin system.

In a paper on "Defects Common to Gray Iron Castings—Their Causes and Remedies", by Herbert M. Ramp, Elmwood Castings Co., Cincinnati, the statement was made that approximately 5 per cent of the iron castings produced are defective and the causes assigned for these losses were proportioned as follows: Sand and its treatment, 50 per cent; cores, 20 per cent; patterns,

10 per cent; equipment, 5 per cent, and iron, 5 per cent.

A paper entitled "Pouring Systems for Gray Iron Foundries", read by H. Cole Estep, engineering editor of *The Iron Trade Review*, Cleveland, was accompanied by lantern slides.

The committee on specifications for gray iron castings recommended that the American Foundrymen's Association take a more active part in the preparation of specifications than has been the case in the past. The appointment of sub-committees to act in conjunction with the general committee was suggested. These sub-committees, it was stated, should formulate specifications for the following classes of castings: Car wheel, pipe, agricultural, steam engine and hydraulic cylinders and chemical. The committee also recommended for adoption the tentative methods proposed for sampling and analysis of pig and cast iron, presented for consideration to the American Society for Testing Materials at its last meeting.

W. D. Putnam, Detroit Testing Laboratory, Detroit, chairman of the committee, who presented the report, made some informal remarks on hardness tests, discussing the various methods for determining the hardness of cast iron and other ferrous metals. Mr. Putnam also demonstrated the operation of the Brinell and Shore hardness testing machines. Considerable discussion ensued regarding the value of hardness tests of cast iron, the concensus of opinion being that this metal contains constituents which tend to make the accurate determination of its hardness difficult. The report of the committee was accepted and referred to the executive board. The report of the committee on standard methods for analyzing coke was presented by its chairman, H. E. Diller, General Electric Co., Erie, Pa.

Steel Sessions

At the steel sessions on Thursday, Sept. 30, six interesting papers and two reports were presented. Three of these papers and one report are published in full elsewhere in this issue: They are: "Dynamic Properties of Steel Employed in the Manufacture of Castings of Various Types", by J. Lloyd Uhler, Union Steel Casting Co., Pittsburgh, Pa.; "Open Hearth Furnace Checker Design", by W. A. Janssen, Bettendorf Co., Davenport, Ia.; "Causes of Shrinkage Cracks in Steel Castings", by William R. Bossinger, Marion Steam Shovel Co., Marion, O., and the report of the committee on steel foundry standards, by Dudley Shoemaker, chairman, and R. A. Bull, supervisor of basic atomization tests, Commonwealth Steel Co., Granite City, Ill.

A paper by James H. Gray, United States Steel Corporation, New York, entitled "Notes on Electric Furnace Construction and Operation in the Steel Foundry", is abstracted as follows:

As a simple competitor of coal or gas in furnishing heat for steel-making processes, electricity is expensive. The electric furnace, however, furnishes a means of producing steel under conditions free from the contamination of oxides and therefore makes possible chemical reactions and metallurgical operations that cannot be realized by the older methods. There are two general types of electric furnaces. In the arc type the heat is applied by an arc or arcs playing into or above the bath, and in this type of furnace the slag is hotter than the molten metal beneath it. In the induction type, the electric current is induced in the bath of metal itself.

After stating that the development of the induction furnace is a task for electrical experts, the author describes the details of modern arc type furnaces, giving special consideration to the hearth and lining, the electrodes, and their control, the transformers, power factor, and tilting mechanism. The advantages of the electric furnace for foundry use are pointed out and it is stated that the electric process is now being used to refine cupola iron for the manufacture of malleable castings.

BEN FULLER WITH THE SMILE THAT WON'T COME OFF

C. S. Koch, Fort Pitt Steel Castings Co., McKeesport, Pa., presented an interesting paper entitled "The Particular Application of the Converter in the Manufacture of Steel Castings", and Robert E. Kinkead, Lincoln Electric Co., Cleveland, read a paper on "The Electric Arc in the Foundry". The report of the committee on specifications for steel castings, by W. C. Hamilton, chairman, American Steel Foundries, Granite City, Ill., was also presented at the steel session.

In the discussion of Mr. Uhler's paper on the dynamic properties of steel castings, the chairman, R. A. Bull, pointed out the lack of uniformity in the results of fatigue tests, which the author explained was due to the heat generated by the testing machine, the pieces attaining a temperature as high as 140 degrees Fahr. Bradley Stoughton expressed the opinion that vibratory tests are more useful in determining the correctness of heat-treating than the ordinary tension, transverse and compression tests.

Converter vs. Open Hearth

The discussion of Mr. Koch's paper brought up the question of the converter versus the small open hearth. W. A. Janssen, Bettendorf Co., Davenport, Ia., stated that converter failures are due frequently to the efforts of inexperienced gray iron foundrymen in making steel castings. The converter, he stated, should not be considered simply as secondary to cupola melting. C. R. Messenger, Sivyer Steel Casting Co., Milwaukee, stated that the converter foundry can successfully compete with open hearth shops on small work because the open hearth foundries cannot handle this class of castings economically in their cleaning and finishing departments, although they may be able to melt the metal and make the molds economically. Mr. Janssen expressed the opinion that in general an open hearth foundry can run as thin sections as a converter plant and on a favorable cost basis. Dudley Shoemaker, confirmed Mr. Janssen's remarks, stating that his experience of six years in operating an open hearth shop on light castings indicated that almost any class of work could be handled economically. It is largely a matter of temperature, he stated, claiming it to be possible to get any required temperature in the open hearth furnace. To handle light work successfully, however, the open hearth foundry should specialize and not attempt to run heavy and light castings at the same time. Bradley Stoughton pointed out that one of the reasons for the failure of companies employing the converter process is that it is possible to go into the manufacture of converter steel castings with comparatively limited capital. Frequently, he stated, concerns go into the converter business without sufficient financial resources and the resulting failure is due in no way to the metallurgical problems encountered.

The discussion of Mr. Gray's able paper on the electric furnace brought out the fact that one of its chief possibilities lies in its ability to use miscel-

laneous raw materials of moderate price. The higher elastic ratio of electric steel also was commented upon, Dudley Shoemaker stating that tests made under his observation showed an elastic ratio of over 50 per cent, using Johnson's method of measuring the elastic limit. Upon the suggestion of H. E. Field, president, Wheeling Mold & Foundry Co., Wheeling, W. Va., a vote of thanks was extended Mr. Gray for his able exposition of his subject.

The report of the committee on specifications for steel castings was accompanied by written arguments in support of the changes suggested by the committee. H. E. Field moved that the report of the committee be laid on the table, stating that in his opinion more harm than good would be done to the foundry industry if the question of specifications for steel castings be reopened. The chairman, Mr. Bull, stated that in his opinion the suggestion of Mr. Field was ill-advised, pointing out the desirability of co-operation between the American Foundrymen's Association and the American Society for Testing Materials in regard to specifications. When put to a vote, Mr. Field's motion was sustained and the report was laid on the table. At the business session the following day, however, a motion to give the committee's report further consideration was passed unanimously. This same motion also recommended the acceptance of the report and directed that the committee be continued.

In the discussion growing out of the report of the committee on steel foundry standards, reference was made to the standard specifications for ladle nozzles adopted at the 1914 convention. Mr. Shoemaker, the chairman of the committee, stated that out of 65 foundries using nozzles to whom inquiries were sent, 40 agreed to either adopt or try out the A. F. A. standard. W. A. Janssen recommended the standard nozzle very highly. It was also pointed out that the adoption of a standard had had the effect of stimulating the brick makers to turn out a product of higher quality. Upon the suggestion of the chairman, Mr. Bull, a motion was presented by Mr. Janssen to the effect that the committee be continued and instructed to investigate the standardization of ladle stoppers. This motion was passed unanimously.

Malleable Session

The meeting devoted to malleable casting practice was unusually well attended, six papers having been presented for consideration. L. E. Gilmore, Baltimore Malleable & Steel Co., Baltimore, presented a paper entitled "An Outline to Illustrate the Inter-Dependent Relationship of the Variable Factors in Malleable Iron Practice".

In this paper various types of furnaces used for producing malleable iron are considered and it is stated, that not only the type of furnace has a predominating influence on its operation, but details of construction, which may be varied, place limitations on the methods of operation. It is pointed out that not only the nature, but also the quality of the fuel greatly affects the furnace operation. Another factor of importance is the nature and condition of the slag, and control of combustion is another item of importance. The author defines an ideal mixture as one which will produce, under the conditions of furnace operations, the desired composition of melted iron as soon as it is hot enough for pouring. The physical condition of the scrap and pig also is a variable that has an important bearing upon the use of these materials. The essentials of the annealing operation are discussed, and the author states in conclusion that the successful and economical production of the best quality of malleable iron is impossible without a comprehensive grasp of the fundamental principles underlying the actions and reactions of the various factors of its manufacture. Without such knowledge, only by chance will good quality be attained.

Duplex Process

In discussing the various types of furnaces and melting processes, Mr. Gilmore referred to the duplex process and he was asked to what extent duplexing is practiced in malleable foundries in this country or abroad and whether or not the air furnace and the electric furnace had been considered as a unit for the melting and subsequent refining of the metal. In reply it was stated that numerous experiments are being made in various plants throughout the United States with electric furnaces for melting malleable iron, but no information was given regarding the success attained. It was pointed out that the electric furnace undoubtedly may be used for refining and it was added that metal from a Heroult electric furnace was so quiet and absolutely dead that it seemed impossible to satisfactorily pour castings therefrom. It was suggested that undoubtedly cupola melted malleable could be refined to advantage in an electric furnace.

The question of the relative advantages of coke and charcoal pig in malleable practice also was discussed as a result of a statement made by Mr. Gilmore, that with charcoal pig it is possible to carry a higher percentage of scrap than when using coke pig iron. It was the opinion, however, of one of the speakers, that equally as good results could be obtained from the use of coke pig iron. In reply to an inquiry regarding the speed of melting and fuel consumption employing sand and chilled cast pig iron, it was stated that heats could be made much more rapidly with chill cast pig iron than with sand cast and it was estimated that the time of melting was reduced from 10 to 15 per cent, also the saving in fuel is considerable.

"Standardization of Air Furnace Practice", was the subject of a paper prepared by A. L. Pollard, Johnston Harvester Co., Batavia, N. Y. This paper appears in full elsewhere in this issue. In the ensuing discussion, the question was asked, what advantages accrue from the application of forced draft to air furnaces. In reply to this inquiry it was stated that heats which ordinarily require eight hours for melting in natural draft furnaces, can be made in from four to six hours in forced draft furnaces with only a slight increase in fuel consumption; in other words, the melting ratio in natural draft furnaces varies from 1:2 to 1:2½, whereas in forced draft furnaces the melting ratio is from 1:2 to 1:3. It was the consensus of opinion that the forced draft furnace is more satisfactory in every way in malleable practice. The use of insulating brick in air furnaces also was discussed, but none of the malleable manufacturers in attendance had yet tried insulating brick between the shell and the inner lining. One foundryman, who operates air furnaces for melting gray iron, stated that in a new furnace that he is now building 4-inch insulating brick is being installed; the lining is 17½ inches thick, with the refractory portion 13½ inches in thickness.

Malleable Specifications

The committee on standard specifications for malleable iron castings presented the specifications which already had been adopted by the American Society for Testing Materials and after some discussion they were approved with the recommendation that during the ensuing year the committee on malleable standards of the American Foundrymen's Association consider the preparation of specific standards applying to various classes of work including castings for agricultural implements, chains, etc., as well as railroad work. J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill., who presided at the malleable meeting, regretted that the limit in tensile strength had been reduced from 40,000 to 38,000 pounds per square inch. It was explained that inasmuch as the elongation had been practically doubled, it was decided to reduce the tensile strength to compensate for this increase. The establishment of uniform specifications was urged which would compel all purchasers to buy on the same basis, and it was stated that the adoption of specific standards for various classes of work undoubtedly would result in early recognition of the standard specifications for malleable castings.

Enrique Touceda, metallurgical engineer, Albany, N. Y., presented, in abstract, the results of his recent investi-

gations into the permissible phosphorus limit in malleable iron castings. In answer to a question regarding the carbon and silicon contents when the phosphorus is increased, he stated that this increase could be made regardless of the variation in silicon and carbon. L. E. Gilmore inquired regarding the effect of an increase of 0.10 per cent in phosphorus with particular reference to the effect on the fluidity of the metal. Mr. Pero stated that it would be difficult to ascertain the results of an increase of so small an amount of phosphorus in a test, although he was certain that the fluidity would be considerably increased as evidenced by the reduced losses from misruns in his plant as a result of increasing the phosphorus for light work from 0.17 to 0.28 per cent. However, there is no appreciable change in the strength of the iron due to increasing the phosphorus to 0.28 per cent and the wedge-test results are practically the same as when melting a mixture containing 0.17 per cent phosphorus.

The sentiments expressed in the paper prepared jointly by J. P. Pero and F. E. Nulsen, of the Missouri Malleable Iron Co., with reference to a production of the highest possible quality of malleable iron, were applauded.

In the absence of F. Van O'Linda, Consolidation Coal Co., Chicago, his paper entitled "Coal—Its Orgin and Use in the Air Furnace", was read by title.

Two business sessions were held, one Wednesday evening, Sept. 29, at which the annual election of officers took place, and the other Friday morning, Oct. 1. Aside from the election, the principal feature of the annual business session Wednesday evening was the annual address of the president, R. A. Bull, which is presented elsewhere in this issue. The reports of the secretary-treasurer and the executive board also were presented and approved. The nominating committee's recommendations were accepted unanimously and the following officers were elected for the ensuing year: President, R. A. Bull, Commonwealth Steel Co., Granite City, Ill.; senior vice president, J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.; vice presidents, Henry A. Carpenter, General Fire Extinguisher Co., Providence, R. I.; S. B. Chadsey, Massey-Harris Co., Ltd., Toronto, Can.; Alex T. Drysdale, United States Cast Iron Pipe & Foundry Co., Burlington, N. J.; H. E. Field, Wheeling Mold & Foundry Co., Wheeling, W. Va.; Benjamin D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland; W. A. Janssen, Bettendorf Co., Davenport, Ia.; H. B. Swan, Cadillac Motor Car Co., Detroit; A. H. Thomas, Buckeye Steel Castings Co., Columbus, O., and Walter Wood, R. D. Wood Co., Philadelphia. Secretary-treasurer, A. O. Backert, also was re-elected. A resolution was passed unanimously increasing the secretary-treasurer's salary from $1,200 to $1,800 per year.

Upon motion of J. S. Seaman, the venerable dean of the American Foundrymen's Association, R. A. Bull, who was re-elected president, was unanimously elected an honorary member. W. H. Barr, president of the National Founders' Association discussed the safety work of the National Affiliated Safety Organizations and also outlined the plans of the conference board to extend its activities into the field of industrial education. Mr. Barr made an earnest plea that the American Foundrymen's Association join in this work. Mr. Barr advised the meeting that the National Founders' Association would be glad to co-operate with the American Foundrymen's Association in its proposed plans for the employment of a cost expert. A motion was passed empowering the executive board to take such action as it may see fit on the recommendations contained in the annual address of President Bull. The committee on the deaths of Thomas D. West and Edgar H. Mumford presented appropriate resolutions, which were unanimously adopted.

MRS. HENRY E. PRIDMORE AND SON

At the final business session Friday morning, Oct. 1, the usual resolutions of thanks were presented by Benjamin D. Fuller and unanimously adopted. A motion made by Joseph T. Speer that President Bull's action in appointing certain committees since the 1914 convention be approved also was unanimously adopted. Mr. Speer's motion contained the provision that the president be empowered to appoint such additional committees as may be necessary during the forthcoming year. Mr. Fuller stated that the city of Cleveland hoped to have the pleasure of entertaining the allied foundry organizations at the 1916 meeting. A similar invitation was received from the New England foundrymen, who suggested that the next convention be held either at Boston or Providence. These invitations, in accordance with the usual custom, were referred to the executive board for action. The motion to adjourn the convention was presented by J. S. Seaman.

The president announced the appointment of the following committees for the ensuing year:

STEEL FOUNDRY STANDARDS.—Dudley Shoemaker, Atlantic Foundry Co., chairman; A. F. S. Blackwood, Michigan Steel Casting Co., Detroit; W. A. Janssen, Bettendorf Co., Davenport, Ia.; L. A. Way, Duquesne Steel Foundry Co., Coraopolis, Pa.; Ralph West, West Steel Casting Co., Cleveland; A. H. Thomas, Buckeye Steel Casting Co., Columbus, O.

SPECIFICATIONS FOR MALLEABLE IRON CASTINGS. — Enrique Touceda, Albany, N. Y., chairman; Alfred E. Hammer, Malleable Iron Fittings Co., Branford, Conn.; W. G. Kranz, National Malleable Castings Co., Sharon, Pa.; F. E. Nulsen, Missouri Malleable Iron Co., East St. Louis, Ill.

GENERAL COMMITTEE ON SPECIFICATIONS FOR GRAY IRON CASTINGS. — W. P. Putnam, Detroit Testing Laboratories, Detroit, chairman; Richard Moldenke, Watchung, N. J.; D. W. Sowers, Sowers Mfg. Co., Buffalo; Joseph J. Wilson, Cadillac Motor Car Co., Detroit. Sub-committees on hydraulic and steam engine, agricultural, pipe, car wheel and chemical castings, to be appointed later.

SPECIFICATIONS FOR STEEL CASTINGS.—To be appointed later.

SPECIFICATIONS FOR FOUNDRY SCRAP.—George E. Jones, Whiting Foundry Equipment Co., Harvey, Ill., chairman. Other members to be appointed later.

SAFETY AND SANITATION.—To be appointed later.

INDUSTRIAL EDUCATION.—To be appointed later.

PAPERS.—To be appointed later.

COSTS.—Benjamin D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland, chairman; E. G. Felthausen, Acme Steel & Malleable Iron Co., Buffalo; H. J. Koch, Fort Pitt Steel Casting Co., McKeesport, Pa.; Roy Tanner, Pittsburgh Valve, Foundry & Construction Co., Pittsburgh.

STANDARD METHODS FOR COKE ANALYSIS.—H. E. Diller, General Electric Co., Erie, Pa., chairman; Paul Debevoise, Debevois-Anderson Co., New York City; A. S. Hummell, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.; R. S. McPherran,

Allis-Chalmers Mfg. Co., Milwaukee; Dr. Richard Moldenke, Watchung, N. J.; J. B. Stoddard, Detroit Testing Laboratories, Detroit.

The numerous recreation facilities of Atlantic City afforded unusual opportunity for entertainment. An informal dance was held on Young's Pier on Monday evening. On Tuesday evening the members of the allied associations attended a theater party on the Garden Pier, after which there was an informal dance interspersed with several special numbers.

The annual banquet at the Traymore Hotel, Thursday evening, Sept. 30, was unusually well attended and exceptionally interesting. John Kendrick Bangs presented his charming address entitled "Salubrities I Have Met", which was received with unusual enthusiasm. Dr. A. A. Hamerschlag, director, Carnegie Institute, Pittsburgh, spoke on "Foundrymen in the Making". He pointed out how difficult it is for employers to obtain men with the requisite intelligence and personality for the proper conduct of their business and he described the methods of Carnegie Institute in selecting and training young men who appear to have special endowment for positions of leadership. The creation of personality, he explained, is the all-important problem. He illustrated this idea by stating that the genius of an Andrew Carnegie was of greater value to the state of Pennsylvania than its material resources in coal and iron ore. Likewise, he felt that the ability of a man like George Westinghouse was of more consequence than the oil resources of the Pittsburgh district.

The registration was unusually gratifying and showed a large increase over the Chicago convention in 1914. A total of 513 members and 209 guests were registered by the American Foundrymen's Association; the American Institute of Metals registered 114 members and 48 guests, bringing the total number in attendance up to 884, which is the high water mark in the history of the allied foundry organizations.

Meeting of The American Institute of Metals

VALUABLE papers containing much new information in regard to aluminum and aluminum alloys, forging and rolling alloys, acid metals, bearing bronzes and other non-ferrous metals and alloys featured the annual meeting of the American Institute of Metals, at Atlantic City, N. J., Sept. 28 to 30, inclusive, in connection with the convention of the allied foundrymen's organization. Some of the important recent developments in the metal industry, which were definitely reported and described at the meeting, are: The discovery of an acid-resisting alloy; further progress in ascertaining the effects of impurities which occur in spelter; the establishment of the aluminum die casting industry on a commercial scale; the development of satisfactory methods for melting aluminum and magnalium chips; a partial solution of the mystery of "season cracking" in brass materials; the uncovering of new uses for aluminum bronze alloys by reason of the marked hardness and endurance properties of the alloys of this system; the development of continuous sherardizing equipment; the manufacture of alumino-vanadium, and the establishment of the fact that the presence of oxides is the principal cause of weakness in zinc bronze.

Some friendly criticism was vented at the meeting, to the effect that the discussions generally were of too scientific a character to be clearly intelligible to the average brass foundryman. This matter received earnest consideration and various recommendations were voiced. As a result, G. H. Clamer, the retiring president, and chairman of the papers committee for next year, announced that among the papers to be read at the next annual convention will be one which will constitute practically an elementary treatise of the science of metals. This paper will define in as simple language as possible such terms as eutectic, thermal diagram, colloid, alpha metal and various others occurring constantly in the parlance of the scientists.

Election of Officers

Jesse L. Jones, of the Westinghouse Electric & Mfg. Co., East Pittsburgh, was elected president for the ensuing year, while W. M. Corse, of the Titanium Alloy Mfg. Co., Niagara Falls, N. Y., was re-elected to the joint office of secretary and treasurer. Vice presidents were elected as follows: R. S. B. Wallace, National Cash Register Co., Dayton, O.; Geo. C. Stone, New Jersey Zinc Co., New York; W. G. Harris, Canada Metal Co., Toronto; C. B. Horne, Packard Motor Car Co., Detroit; W. B. Price, Scovill Mfg. Co., Waterbury, Conn.; E. A. Barnes, Ft. Wayne Electric Co., Ft. Wayne, Ind.; Dr. S. H. Burgess, bureau of standards, Washington, D. C.; F. H. Schutz, Mueller Mfg. Co., Decatur, Ill.; H. S. Gullick, More-James Brass & Metal Co., St. Louis, and D. B. Browne, Goldschmidt Thermit Co., New York.

Thos. J. Wettstein, United Lead Co., New York, presented a paper dealing with the effect of the war on nonferrous metal prices.

In addition to giving his own views on the subject, Mr. Wettstein's paper induced a short discussion, to which Geo. C. Stone, of the New Jersey Zinc Co., was an interesting contributor. Speaking strictly with reference to conditions in this country, Mr. Wettstein said that the non-ferrous metals on account of their wide use in modern warfare, are subjected as a result of war to the widest price fluctuations ever known. "One may easily conclude that the non-ferrous metals with the sole exception of antimony", said Mr. Wettstein, "while undergoing at times wild fluctuations because of urgent covering operations attending the placing of war contracts, in the end will have been found fairly stable in values, largely due to the equalizing influence of the war demand with a largely diminishing demand from the fields of peace. Moreover, the deposits of these metals in America are so extensive that production may keep well in line with the changing demands. Antimony, however, cannot be so classified and unless new deposits are found, this metal must continue scarce, so long as a war demand exists for it in its present volume." Tin is not widely used for war purposes, Mr. Wettstein stated, and he assigned the high prices which prevailed late last year as being due to the activities of German cruisers in eastern seas. During the past six months, there have been no interruptions to the tin traffic and prices since have declined steadily.

In discussing this paper, Mr. Stone said the present situation in the spelter market is due to our having to supply 150,000 tons of spelter a year, which formerly was supplied by Germany and Belgium. Furthermore, a change in the character of the demand has complicated this situation, since, for war purposes, only the better grades of spelter are entirely satisfactory. The demand for prime western spelter now is about 60 per cent greater than normal while prices on such brands are 300 to 400 per cent higher than normal. On the other hand, the demand for high grade spelter now is 800 to 900 per cent greater than usual, in view of which, he said, it is remarkable that prices on high grade, which usually are 40 per cent higher than prime

western now only are about 30 per cent higher.

W. H. Bassett, in discussing Mr. Wettstein's paper, spoke of the effect of the great spread which prevailed between the prices of lake and electrolytic copper after the war broke out. A number of ammunition makers in this country and some foreign governments, he said, when they were asked to pay heavy premiums on lake copper, decided to use electrolytic instead of lake. In a number of cases, he said, entirely satisfactory results have caused these purchasers permanently to substitute electrolytic for lake copper in their specifications and it is likely that further substitutions along this line will develop in the near future. Another speaker, questioned in regard to antimony production in this country, admitted that there are many workable deposits of antimony ore in the United States. The cost of production from these ores at the present prices would leave a good margin of profit but following the termination of the war, when normal prices again are expected, production from domestic ores could be conducted only at a loss.

Season Cracking of Brass

A paper by Dr. P. M. Merica entitled "The Failure of Structural Brass", contained an investigation of the causes of so-called season cracking of brass with especial reference to the general failure of such material in connection with the Catskill aqueduct project. Such failures, he said, occur as far as now known, only in brass which has been worked. They are seemingly independent of composition, and fissures or fractures occur in general transversely to the direction of the working. It has been shown, he said, that such working material is in a state of internal stress after finishing, the principal stresses being apparently in a direction parallel to the direction of rolling or drawing. Failures in brass materials similar to season cracking, are due primarily to the presence of these internal stresses and it should be the object of the manufacturer to produce material free from them. In this connection, he said, it is possible to make naval brass, practically free from internal stress. These stresses, he said, may be almost entirely removed by annealing at temperatures of about 300 to 400 degrees Cent.

In discussing the paper presented by Dr. Merica, Wm. R. Webster expressed the reluctance with which brass manufacturers accept specifications which are imposed on them by consumers. One reason for this reluctance, is the scarcity of literature which would enable engineers to draw up satisfactory specifications. Brass making, said Mr. Webster, primarily is an art, and the brass maker determines the suitability of his material by means of its physical properties as well as by the process and the methods of manufacture. When he receives specifications, he feels he has to alter his methods in order to secure requirements which may or may not be desirable.

Wm. B. Price, continuing the discussion, entirely agreed with Mr. Webster. He mentioned a recent case in which 20 per cent of the cartridge cases in a warehouse submerged by a flood, failed, while the remaining 80 per cent showed no sign of deterioration. An investigation revealed the fact that the appearance of cracks was confined to such cases as were provided with primers, which led to the conclusion that cracks were due to corrosion caused by the action of moisture on the fulminate of mercury in the primers.

Jesse L. Jones, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., submitted a paper on "The Manufacture and Uses of Wrought Manganese Bronze". It contained specifications for the composition of manganese bronze bars and sheets, and the limits of the permissible impurities for the constituent copper and zinc. The importance of using pure materials was emphasized and a maximum amount of ductility with a moderate degree of strength was recommended. The paper also included a description of the methods of melting, pouring and forging this alloy.

Aluminum-Bronze Alloys

W. M. Corse, Titanium Alloy Mfg. Co., Niagara Falls, N. Y., presented a paper on "Aluminum Bronze Alloys", which contained information supplementary to the eighth report of the alloys research committee of the Institution of Mechanical Engineers of Great Britain. The hardness of aluminum bronze alloys, said Mr. Corse, is affected by that treatment to such an extent that this change in hardness develops new uses for the alloys. Aluminum bronze alloys of approximately 10 per cent aluminum, heated to different temperatures up to 800 degrees Cent., for instance, will give, on quenching, hardness numbers varying from 100 Brinell to 260 Brinell. Another valuable property of such bronze is its ability to withstand alternating stresses without showing fatigue. Comparing aluminum bronze with manganese bronze of the same strength it was found that the aluminum bronze resisted stresses above its elastic limit for an average of 15,000,000 reversals in a White-Souther machine, while manganese bronze broke at less than 1,000,000. In the Landgraf-Turner endurance testing machine the aluminum bronze resisted 4,500 blows before fracture, while the manganese bronze resisted about 500.

A paper by Russell R. Clarke, Pennsylvania railroad, Pittsburgh, deplored the lack of anything approaching standardization in the composition of railroad car-journals. This paper will be published in a later issue of *The Foundry*.

Car Journal Bearings

G. H. Clamer, Ajax Metal Co., Philadelphia, presented a paper entitled "Effect of Changes in the Composition of Alloys Used by the American Railways for Car Journal Bearings". Originally, said Mr. Clamer, it was the general opinion that a bearing should be as hard as possible and as a result high tin alloys were used. It was not until about 1870 that soft metal linings came into vogue, eliminating to a great extent the occurrences of hot boxes which had become a serious source of annoyance. Somewhat later the addition of lead to the mixture was found to be beneficial, as well as economical. With increasing competition among journal manufacturers, he said, the latter sought means of cutting down their costs, using first scrap of low zinc content and finally using scrap of unknown composition and quality. This condition finally led to zinc contamination in the bearings of practically every railroad of the country. It would be highly desirable, he said, if a uniform and standard specification could be enforced on all the railroads of the country.

Gilbert Riggs and Henry C. Morse presented a paper entitled "The Effects of the Common Impurities in Spelter upon Slush Castings". This paper set forth further data obtained from investigations supplementary to those described by Geo. C. Stone at last year's meeting of the institute. The process of slush casting, which is used extensively in the manufacture of objects of an ornamental character, is conducted as follows: The molten metal is poured into a hollow mold and immediately poured out, leaving a fine-walled casting chilled upon the inside surface of the mold. To facilitate the removal of the molten lead the mold usually is mounted upon trunnions. Slush castings often are electroplated, stained or otherwise treated to produce color effects. The surface of a slush casting not only

must be smooth and free from visible flaws, but also must be free from any microscopically small cracks or pin holes, since such flaws tend to take up some of the liquor from the plating solutions and thus cause a strain to appear later. It is apparent that the appearance and usefulness of a slush casting is entirely dependent on the quality of the metal used in its manufacture. The authors described a long series of tests undertaken in order to ascertain definitely the influence of the impurities of spelter on the cracking of slush castings. Their investigations showed clearly that the purer the metal the better is its behavior.

In reference to aluminum-spelter alloys, Wm. B. Price said that by using aluminum in the proportion of one part to 19 parts spelter and introducing the resulting alloy into the casting mixture in amounts constituting about 0.005 per cent of the latter, all tendency toward the appearance of cracks in the slush castings was eliminated. In reply to a question in reference to the possibility of successfully plating slush castings made from an aluminum-spelter alloy, Mr. Riggs stated that four or five months after plating, such coatings still are in the best of condition but that he expects to conduct further investigations along this line.

Dr. S. Trood, United States Sherardizing Co., New Castle, Pa., contributed an interesting paper devoted to the theoretical and practical principles governing the process of sherardizing.

Ernest V. Pannell, of the British Aluminum Co., Toronto, submitted a paper on "Recent Developments in Aluminum". Since the first overhead aluminum lines for electric power transmission were strung in this country in 1898, stated Mr. Pannell, there has been an annual increase in the consumption of aluminum for electrical work which has been more or less marked according as the price of copper has been high and low.

Die Castings and the War

Another paper presented during the session on aluminum and aluminum alloys was that on "Aluminum Die Castings a Commercial Achievement", by Charles Pack, of the Doehler Die Casting Co., Brooklyn. At the present time large quantities of aluminum are being converted into die castings each month by the Doehler process, the products including spark levers, throttle levers, spark and throttle sectors used on most of the higher-priced automobiles. The alloy employed is strictly aluminum-copper, and does not contain any zinc, tin or cadmium. Aluminum die casting, however, cannot economically replace zinc alloy die casting where the latter is satisfactory, since while the die for zinc alloys will last almost indefinitely, the best die material when used with aluminum alloys will not produce more than 5,000 castings without heat checking. The high cost of producing dies thus adds largely to the cost of the resulting castings. Mr. Pack spoke of the effect of the European war on the die casting business. In normal times, with zinc at 7c, copper at 16c and tin at 40c, the cost of the average die casting alloy is 12c per pound. The high metal prices which have prevailed since the outbreak of the war have presented difficult problems to the die casting manufacturers, principally in view of the fact that zinc, on which prices have been some several hundred per cent higher than normal, formerly constituted about 85 per cent of the die castings produced. The high prices on zinc have been responsible largely for the efforts expended in aluminum die casting, since aluminum, considering the specific gravity, exceeds only lead in cost.

Jesse Lee Jones

Jesse Lee Jones, elected president of the American Institute of Metals at Atlantic City, Sept. 29, was born at Martins Ferry, O., in 1865. After being graduated from the high school at that city he served an apprenticeship in a gray iron foundry where he laid the foundations for his subsequent metallurgical work. In 1903, Mr. Jones accepted a position with the Westinghouse Electric & Mfg. Co. at East Pittsburgh, Pa., being attached to the manager of works department. Later, he was attached to the research division of the engineering department and subsequently became chief chemist, still paying particular attention to various foundry problems. He has been a frequent contributor to the technical press on foundry practice and is author of the text on "Brass Foundry Practice," used by the International Correspondence Schools.

Henry S. Rawdon presented a paper entitled "Standard Test Specimen of Zinc Bronze: Copper 88, Tin 10, Zinc 2". The work described in this paper constituted a part of the study of the properties of this standard zinc bronze, the preparation of which was described in the 1913 and 1914 proceedings of the Institute. In brief, the author's conclusion from study of the microstructure was that, of the various causes of weakness, the presence of oxides is most important. Samuel L. Hoyt presented a paper entitled: "Notes on the Copper-Rich Kalchoids", which constituted a continuation of the author's paper presented at last year's meeting of the Insttute.

In discussing Dr. Rawdon's paper, C. P. Karr explained that the tests described in the paper had been conducted without the use of a deoxidizing agent, and he admitted the value of the results obtained. He suggested that in pursuing further investigations along this line, such agents should be employed in an effort to strengthen the alloy. As desirable deoxidizing agents, C. Vickers suggested phosphorus, manganese and barium.

H. W. Gillett presented a paper devoted to the melting of aluminum chips, an operation difficult of performance by most foundrymen. The chips, the moment they are cut, are coated by a thin film of oxide which, when they are heated, prevents the metal within the chips from coalescing and liquifying at the melting point. The presence of fine dirt such as floor sweepings serves to reinforce the oxide film, making the problem still more difficult of solution. Mr. Gillett described two processes for melting aluminum chips which are in successful use. One of these is a puddling process, while the other is based on the same principle as aluminum welding.

Another paper on a related subject was that by John Coulsen, of the engineering department of the Westinghouse Electric & Mfg. Co., Pittsburgh, on the reclamation of magnalium from turnings. This metal, an alloy of aluminum and magnesium, now is used on such an extensive scale at the Westinghouse plant that the recovery of the metal in the turnings is a matter of importance. For this purpose there has been developed a puddling process which has proved highly successful.

Acid-Resisting Alloy

S. W. Parr, of the University of Illinois, contributed the results of an investigation designed to discover an acid-resisting alloy which might be employed advantageously as a substitute for platinum. As a result, a complex alloy was developed which did not show a weighable loss after contact with nitric acid for 24 hours. The paper contained full details in regard to the composition of this alloy. Mr. Parr also contributed a paper, entitled "Methods of Analysis for Complex Alloys".

A paper entitled "The Alloys of Chromium, Copper and Nickel", presented by David F. McFarland and Oscar E. Harder, gave the results of another investigation, recently pursued at the engineering experiment station of the University of Illinois. The conclusion derived was that, from the present information, the alloys of chromium-copper-nickel which show possibilities of becoming of commer-

cial value are limited to certain rather well defined ranges of composition. Such of the alloys as promise most from the mechanical and physical standpoints, show also, as a rule, the best resistance to corrosion in practically all of the solvents used.

Alumino-Vanadium

W. W. Clark, Seymour Mfg. Co., Seymour, Conn., submitted a paper containing a description of the manufacture and use of alumino-vanadium. This paper comprised data resulting from an effort to discover some form of vanadium in which the fatigue-resisting and other desirable properties of vanadium might be embodied in non-ferrous metals in the same manner as they are embodied in steel. Since pure vanadium is almost insoluable in brass, bronze, German silver, etc., an investigation was made of the suitability of its various alloys. To this end, a number of unsuccessful attempts were made to alloy the metal with copper. Aluminum finally was tried, and the results obtained were entirely satisfactory. Alloys of aluminum, containing from 2 to 30 per cent vanadium, were obtained and little difficulty was encountered in regulating the vanadium content. The alloys ranging from 10 to 20 per cent vanadium were most easily worked and appeared to dissolve in the brass more readily than those having a higher content. Among the difficulties encountered in the use of alumino-vanadium was the tendency of aluminum in alloys of copper and zinc and zinc and nickel to make the metal brittle when rolling. In drawing metal, such as cupro-nickel, aluminum is objectionable, as the metal hardens too quickly. Nickelo and mangano vanadiums are as easily made as alumino and except for higher melting points, as easily used. It is very doubtful, the author said, that small amounts of vanadium will increase the tensile strength of non-ferrous metals, except through its effect as a deoxidizer.

The results of an investigation of fusible tin boiler plugs were set forth in a paper by Dr. G. K. Burgess and P. D. Merica, of the bureau of standards, Washington. Tin, the authors stated, generally is used as the fusible material in boiler plugs and has many advantages in this respect. Carelessness in its use and inspection, however, often has led to boiler accidents due to the failure of the tin to function properly. Investigation of approximately 1,100 plugs, both new and used, at the bureau of standards has shown that unless the tin used in such plugs is pure, it is subject to oxidation when in service. The oxide has a melting point above 1,600 degrees Cent., and it often forms in such a way as to prevent the blowing out of the remaining tin, thus preventing the plug from giving warning of overheating in the boiler. The tin in all cases where such oxidation occurred was impure, containing from 0.3 per cent to 5 per cent of zinc or lead. In no plugs containing pure tin was there any trace of oxidation. As the safest practice, the authors recommended for boiler plugs the use of tin 99.9 per cent pure, and containing less than 0.01 per cent each of zinc and lead, which would admit only Banca and other pure tins. The authors thought it probable, however, that tin 99.8 per cent pure and containing less than 0.01 per cent zinc

JESSE L. JONES,
President, A. I. M.

and 0.50 per cent lead is sufficiently pure for use in fusible plugs, and such a specification would include most of the high grade brands of tin on the market.

The Dominion Steel Foundry Co. Ltd., Hamilton, Ont., Canada, will erect an extension to its foundry for the manufacture of chilled, sand and semi-steel rolls. The General Laboratories, Canton, O. have been engaged as consulting engineers and will place contracts for all of the equipment purchased.

The executive offices of the Tropenas Converter Co., New York City, have been removed to the company's laboratory at 2243 Nostrand avenue, Brooklyn, N. Y. The New York City offices at 50 Church street, however, will be continued.

Green or Dry Sand Core

By W. J. Keep

Question:—We are casting a pattern containing a large core and we would like to know whether it is advisable to use dry or green sand cores. We believe that a dry sand core is cheaper and more economical in every way. The casting is ¼-inch thick at its heaviest cross-section and 3/16-inch at its lightest cross-section; the crown face is 5 inches, the head is 23½ inches in diameter, and it is 34 inches over-all.

Answer:—With the proper rigging, a green sand core will make the cheapest job. However, since you are in favor of dry sand cores and have excellent facilities for making them, they certainly shoud give you good casting results. After you have used dry sand cores you might try green sand and then estimate the cost. The method that is the cheapest is the one that should be adopted.

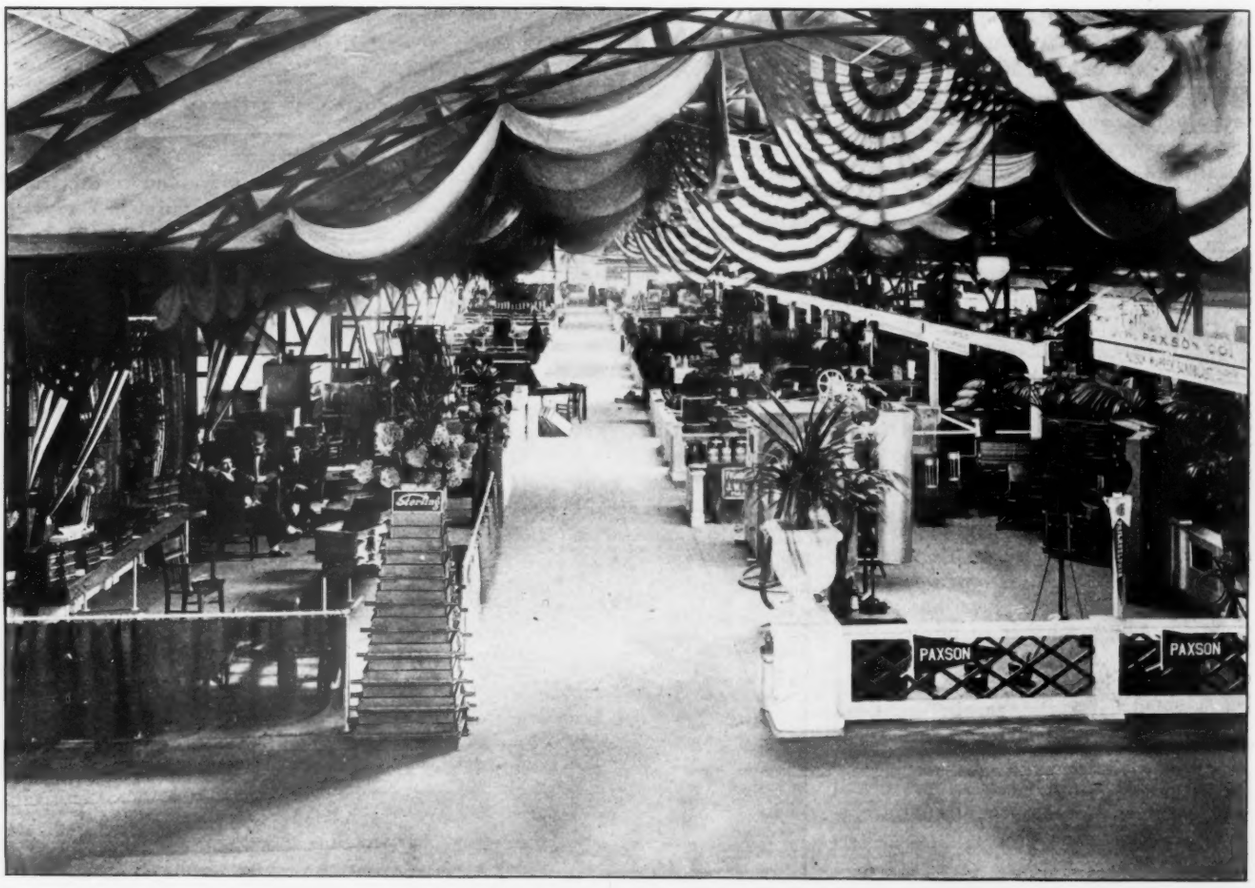
Rough Drum Castings

Question:—We are making drum castings and find that they are defective when machined. After the first cut small spots appear on the inside and outside of the castings. The second cut, however, seems to remove most of the spots. In molding these drums, heap sand with a fair amount of mixed facing scattered through it, is used, being riddled through a ¼-inch screen.

All of the cores are anchored, so there is a good chance to finish both the mold and the core. The plumbago is applied with a brush and also by hand, but the castings do not come out as smooth as desired. The castings are poured from the top through drop gates.

A very careful microscopic examination has been made of some of the defective parts and it showed fine particles of sand entrained in the casting. The molds are poured with hot iron. Is there anything wrong with the sand mixture?

Answer:—I presume that you mean that you are using sand with sea-coal facing mixed with it. The result of your microscopical test indicates that there is not strength enough to the sand on the face. You might spray the surface with molasses water to hold the particles of sand from washing off the surface. The smoothness of your castings depends upon the fineness of your facing sand. The sand against the pattern should be passed through a riddle fine enough to give you the surface that you want. If good plumbago is applied with a brush the sand should not burn into the surface of the casting.



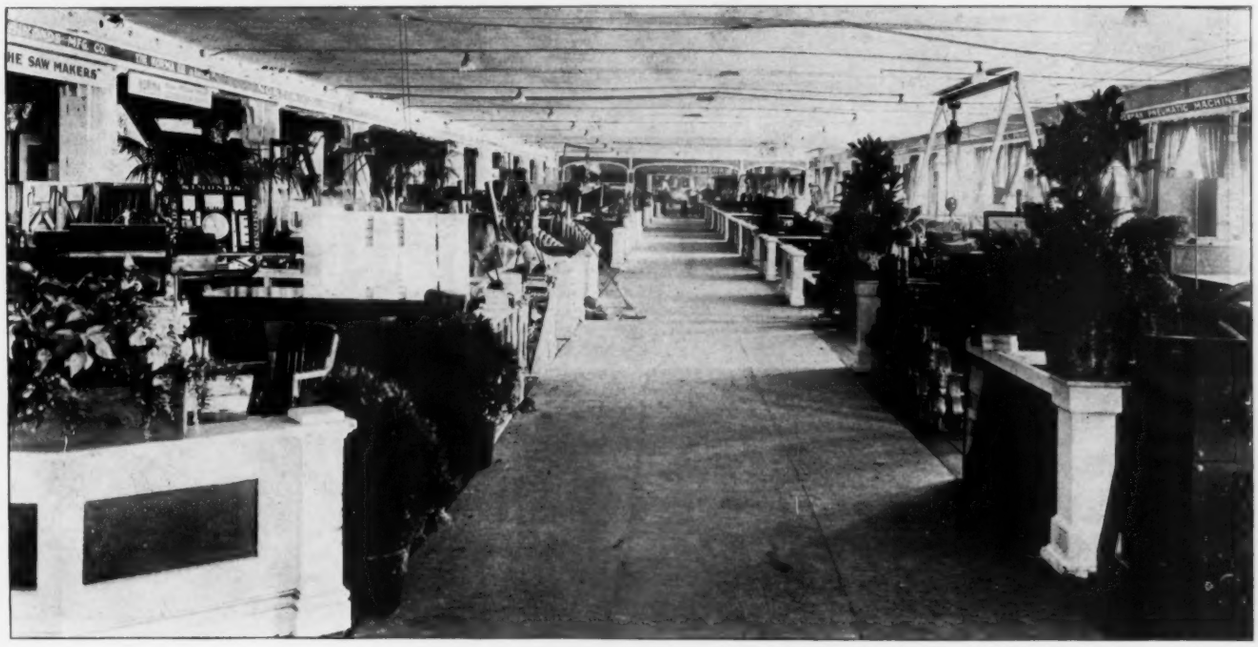
GENERAL VIEW OF EXHIBITS IN THE ANNEX

EXHIBITS IN MACHINERY HALL EXTENSION SHOWING SNYDER ELECTRIC FURNACE IN FOREGROUND

Exhibits at Foundry Convention Attract Interest

Great Progress in the Design and Construction of Foundry and Shop Equipment Reflected in the Displays on Young's Pier

UNUSUAL facilities both for the entertainment of visitors and the display of foundry and shop equipment combined to give a distinctive character to the tenth annual Foundry and Machine Exhibition, which was held on Young's Million Dollar Pier at Atlantic City, N. J., concurrent with the annual convention of the American Foundrymen's Association and the American Institute of Metals. The show, which was conducted under the auspices of the Exhibition Co., opened at 10 a. m., Saturday, Sept. 25, and closed Friday evening, Oct. 1.



MAIN AISLE IN MACHINERY HALL

Owing to the fact that Atlantic City is purely a pleasure resort without industrial business establishments in the immediate vicinity that might divert the attention of the visitors, it was decided not to operate the exhibit during the evenings, as heretofore, although the display was open and lighted after the dinner hour for the benefit of those who might wish to make superficial inspections or to avail themselves of the usual ball room and promenade attractions of the pier.

The show, which just closed, was the first to be held east of the Allegheny mountains since 1907, when the convention and exhibition took place in Philadelphia. It served to attract, therefore, a large number of foundry and shop executives from the eastern states who had found it impossible to attend the immediately preceding shows, and these, combined with the large number of westerners who took advantage of the opportunity to renew their acquaintance with the Atlantic seaboard, served to swell the attendance to unusually large proportions. The manifold attractions of Atlantic City as a pleasure and health resort also, undoubtedly, added to the number of visitors.

A comparison of the 1915 exhibition with that held in Philadelphia in 1907 reflects the tremendous progress of the metal working industries during the past eight years. At Philadelphia there were 67 exhibitors; at Atlantic City there were nearly 125, or double the number at the last previous eastern show. This increase in the number of exhibitors finds its counterpart in the increased space occupied by the various displays, which has much more than doubled in the period under consideration. Furthermore, this expansion indicates a rapid and healthy growth in the importance, wealth and volume of business of the exhibitors and the industries to which they cater; in fact, the growth of the metal trades in power and wealth during the past few years has been matched only by their corresponding advances along technical lines.

At the Philadelphia exhibition the molding machines were of a comparatively simple character; the combination machines of the present day had not been invented. Many of the auxiliary appliances now considered indispensable in up-to-date foundries for handling sand and other raw materials, for controlling melting processes and for trimming, cleaning and finishing castings were unknown eight years ago. At that time also, the electric furnace, as far as the practical foundryman was concerned, was in its infancy, and many of the other applications of electricity to foundry work with which we are familiar today, such as arc welding, were in their incipient stages. Sand blasting, as we understand it now, was unthought of and production records that are commonplace at present were considered unattainable.

The ingenuity of man, however, has no apparent limits and there is little doubt that the approaching decade will witness developments of a mechanical and technical nature far surpassing those covered by the period between 1905 and 1915. Along

material lines, the progress of the human race moves with ever increasing rapidity, as the boundaries of physical knowledge become further extended. Even a devastating war that has perverted the productive energies of over half the civilized world for more than a year has not stayed the march of progress. Tangible evidence of the important technical advances during the past year of bloodshed and disorganization was found in many of the displays at the Atlantic City convention.

Increasing Use of Electricity

The molding machine manufacturers have been busy improving their product in many directions. Electricity is now utilized for performing many operations heretofore possible only by hand or with compressed air. The foundryman, therefore, now has a choice between pneumatic or electrically operated devices, and the necessity for hand labor in putting up molds has all but disappeared. Machines are now provided which not only ram the molds, roll over the flasks and draw the patterns, but also propel themselves along the floor as the sand heap is consumed.

The Osborn Mfg. Co., Cleveland, displayed a complete electrically-driven jar-ramming roll-over pattern-drawing machine, which may be constructed to handle molds of the largest size. The jarring motion is provided by two cranks, running in an oil bath and driven by a 7-horsepower motor, the customary cam mechanism having been dispensed with. The mold is rolled-over and the pattern drawn by another motor of 3½-horsepower operating through a worm gear. This motor is controlled by an automatic push button system, the jam-ramming motor being controlled by a one-point controller of the crane type. The operator's duties are, therefore, exceedingly simple and all of the machine movements are executed by one of the two electric motors. The 42-inch machine shown at the exposition had an 18-inch draw and has been successfully employed in turning out castings for an eight-cylinder automobile motor. A special foundation of ten piles, driven into the sand under the pier, was provided for this machine. In addition the Osborn company displayed several types of squeezers, including split-pattern, jolt and plain squeezers, the latter being provided with sand-straddle base; a jolt-ramming machine for making cores, a small roll-over machine, a roll-over hand jolt, roll-over rock-down and roll-over drop-draft machines also were shown.

AISLE IN MACHINERY HALL

Combination Split-Pattern Machine

A new combination jolt and squeeze-ramming split-pattern machine was shown by the E. H. Mumford Co., Elizabeth, N. J. For certain classes of work, where there are intricate parts to the mold and pockets of sand, the combination of jolt and squeeze ramming is particularly desirable. In the Mumford machine, the jarring cylinder is placed inside the squeezing cylinder: a 4½-inch jolt cylinder and 12-inch diameter squeezing cylinder was provided on the 14 x 16-inch machine on display. This machine is equipped with a mechanism whereby the pattern is started from the sand by hand and finished by power after a draft of 1 inch. The Mumford exhibit also included plain jolt-ramming machines, plain squeezers, etc., built after the designs of the late E. H. Mumford.

Pattern Drawing Machine

The extensive exhibit of the Tabor Mfg. Co., Philadelphia, in the machinery hall extension, included a new portable combination shockless jarring roll-over and pattern-drawing machine involving an unusual combination of operations. This machine combines the characteristic Tabor shockless jar-ramming and roll-over straight draw features in one apparatus. The machine exhibited, which was of 18-inch nominal size, provided with 8-inch straight pattern draft, is designed to handle flasks 18 inches wide, 36 inches long and 12 inches deep, weighing not to exceed 450 pounds, with 80 pounds per square inch air pressure. The Tabor exhibit also included examples of the several other types of machines manufactured by this concern, all of the equipment being shown in operation.

Operating exhibits of the extensive line of molding machines manufactured by Henry E. Pridmore, Chicago, were found in the machinery hall. Prominent in this display was a new combination jar-ramming rock-over drop machine and an electrically driven squeezer. A complete description of the latter machine will appear in a later issue of *The Foundry*. The Pridmore exhibit also included machines of the following types: Stripping plate, hand rock-over drop, power rock-over drop, squeezer, plain electric and combination jarring.

The latest types of Modern molding machines were displayed by the Arcade

Mfg. Co., Freeport, Ill. In addition to their usual features, these machines are now provided with a pneumatically operated ratchet mechanism by means of which they may be propelled along the sand heap as the work progresses. This relieves the molder of considerable arduous labor and tends toward greater efficiency. In addition the Arcade company showed jolt-ramming machines, both plain and combination types; squeezer machines operated by hand or air; core jolters and other equipment including the Brillion pouring device developed by the Brillion Iron Works, Brillion, Wis.

The Berkshire Mfg. Co., Cleveland, featured its standard automatic type of machine. This machine not only performs molding operations, but riddles and handles the sand, being equipped with suitable elevators, hoppers, sifting devices, etc. Air and hand-operated squeezer machines were also displayed, together with core machines, vibrators, special flasks, etc.

Molding Equipment

The Buch Foundry Equipment Co., Bridgeport, Pa., made an operating exhibit of molding equipment including a hand jar-ram, squeezer, roll-over and pattern-drawing machine, and an electrically operated jar-ramming squeezer, roll-over and pattern-drawing machine.

The well known line of machines produced by the Herman Pneumatic Machine Co., Zelienople, Pa., was adequately represented with working displays including a 40 x 56-inch machine provided with independent turn-over and pattern-drawing device. A combination jar-ramming squeezing and stripping plate machine also was displayed, together with numerous other examples of modern molding equipment. The use of snap flasks in connection with split patterns and match plates was demonstrated.

The International Molding Machine Co., Chicago, showed air and electric-jarring machines, combination jar-ramming turn-over draw machines, plain turn-over draw machines, stripping-plate machines, stationary and portable power squeezers, combination jolt squeezers and core machines, the later forming an important feature of the International exhibit.

Jolt-Ramming Roll-Over Machine

The Midland Machine Co., Detroit, displayed a light 6-inch jolt-ramming roll-over machine in operation; this machine has lifting capacity up to 1,000 pounds and will handle flasks up to 32 x 42 inches with a 12-inch pattern draw. The other equipment exhibited included a hand roll-over machine, a small core machine and an interesting pneumatic riddle of new design.

The Mumford Molding Machine Co. and the Vulcan Engineering Sales Co., Chicago, in addition to displaying the working, sectional model shown at the Chicago convention in 1914, exhibited the Krause electro-pneumatic jolt-ramming machine, which is self contained and provides its own compressed air.

A roller-ramming machine of an improved type was displayed by Richey, Brown & Donald, Inc., Maspeth, New York City. The roller is operated by a broken-link rack bar, which enters a pit at the base of the machine. This reduces the floor space required to a minimum. The machine is provided with adjustable sides to permit the use of patterns of varying widths. The drawing plate and pattern are supported by two air springs, thereby balancing the weight and making the operation easy. A standard vibrator is provided and the working parts are enclosed. This machine is specially adapted to molding large, flat, plate-like castings.

The Wood system of taper snap flask molding was demonstrated by a working display. This system, developed by T. B. Wood's Sons Co. Chambersburg, Pa., involves the use of taper snap flasks and automatic adjustable snap jackets as described in full in *The Foundry*, September, 1914.

A complete line of pneumatic vibrators ranging from ⅜-inch to 2 inches piston diameter was shown by the Malleable Iron Fittings Co., Branford, Conn. Practical demonstrations of the operation of these vibrators were made.

Modern steel flasks of all sizes were exhibited by the Sterling Wheelbarrow Co., Milwaukee. Successive improvements have made it possible to steadily increase the size of these flasks and it is not believed the limit has yet been reached.

Electric Furnace Demonstration

An exceedingly interesting demonstration of the foundry possibilities of the electric furnace was furnished by the Snyder Electric Furnace Co., Chicago, which installed and operated a small steel furnace on the pier. Power was supplied in single-phase form by the local public service company and the necessary transformers and auxiliary apparatus were provided by the

LARGE DISPLAY OF SAND BLAST EQUIPMENT BY PANGBORN CORPORATION

Snyder company as a part of the exhibit. Cold scrap was melted and heats were poured frequently throughout the week. The finished castings were cleaned and machined by other exhibitors. In addition, tests of the metal poured from each heat were made in Philadelphia.

The furnace, which was of the one-ton-type, had a capacity of ten tons per 24 hours. The electric furnace is still enough of a novelty in metallurgical circles to attract a large amount of attention, and the Snyder exhibit therefore formed one of the striking features of the 1915 Foundry and Machine Exhibition.

The Monarch Engineering & Mfg. Co., Baltimore, displayed a complete line of furnaces for melting brass and other non-ferrous metals and also for heat treating steel and for tool room use. Among the interesting features of this display was a coke furnace for No. 150 crucibles provided with rotating grate bars. A drop bottom pit or stationary type furnace with shaking grate and a No. 25 crucible tilting combustion chamber furnace also was shown.

The Whiting Foundry Equipment Co., Harvey, Ill., made a pictorial display of its cupolas, together with its other lines of foundry equipment.

Crucibles of American Clay

The war in Europe has cut off the customary German sources of crucible clay and consequently crucible manufacturers in this country have been busy during the past year developing American clay deposits. The results have been exceedingly successful and it is doubtful if many of the manufacturers concerned will revert to the German product after the close of hostilities. Crucibles of American clay have been thoroughly tested and proved satisfactory. In its investigation of American clays, the Jonathan Bartley Crucible Co., Trenton, N. J., tried out over 75 different kinds and found that the best results were obtained by mixing various clays in the proportions necessary to secure the desired results. The Bartley Co. showed used American clay crucibles that had stood from 25 to 50 heats on brass and an average of four heats in crucible steel foundries using oil-burning furnaces of the Milwaukee type.

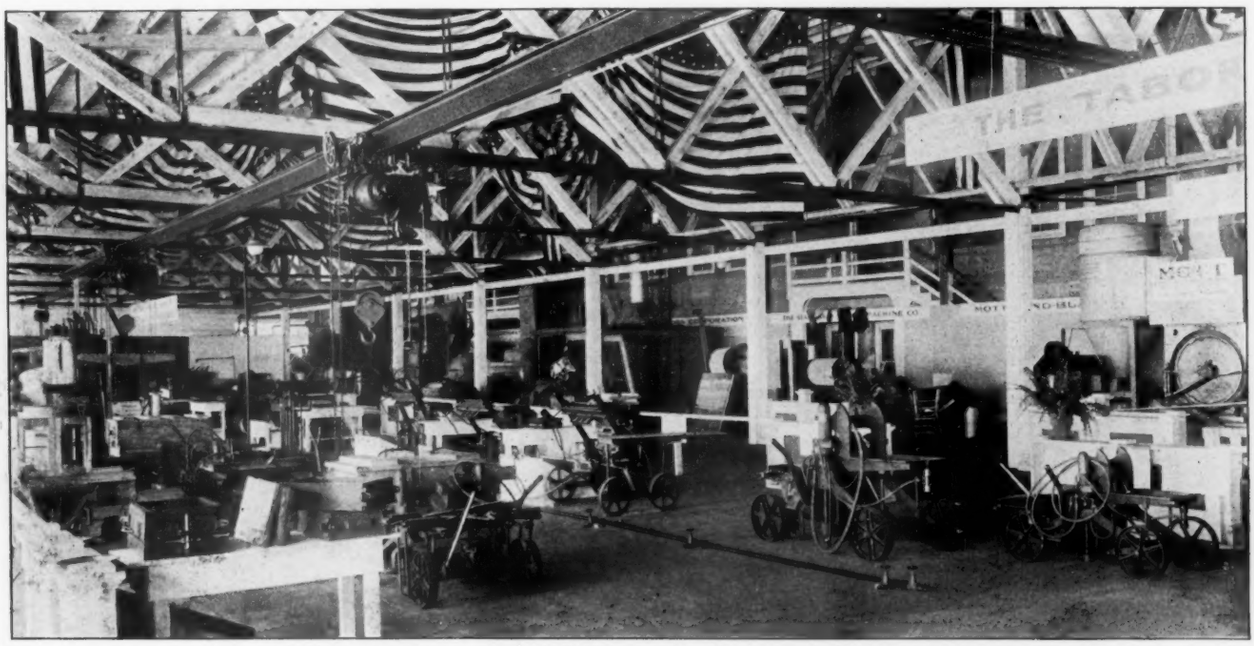
The Joseph Dixon Crucible Co., Jersey City, N. J., also displayed an extensive line of crucibles and other graphite and clay products suitable for foundry use.

Charles J. Clark, Chicago, demonstrated his well-known blast meter for cupola and malleable furnaces.

The exhibits of cleaning room equipment were very extensive, including all types of apparatus found in the modern foundry for cleaning and finishing castings. The tremendous improvements in sand-blast machinery during the past year or two were graphically portrayed.

An exceedingly complete exhibit of sand-blasting apparatus was made by the Pangborn Corporation, Hagerstown, Md., including 11 pieces of equipment, seven of which were in operation, representing 10 different methods of sand blasting. This equipment included a complete sand-blast room, together with sand-blast tumblers, and machines of the cabinet, barrel, table and other types. A complete dust exhaust and sand handling system was provided and the apparatus, which occupied almost all of one side of the machinery hall extension, was driven by a specially installed line shaft connected to an electric motor. Castings obtained from the Snyder electric furnace across the aisle and from other sources were sand-blasted and cleaned throughout the week.

A large direct-pressure type sand-blast barrel was displayed by the Mott Sand Blast Mfg. Co., Chicago. The American Foundry Equipment Co. division of the Sand Mixing Machine Co., New York, displayed several new Wadsworth type sand-blasting machines, including an automatic apparatus for the continuous blasting of radiator columns. Among the other concerns exhibiting sand-blast apparatus and cleaning room equipment were the Brown Specialty Machinery Co., Chicago; Cleveland Pneumatic Tool Co., Cleveland; Ingersoll-Rand Co., New York; New Haven Sand Blast Co., New Haven, Conn.; Norton Co., Worcester, Mass.; Carborundum Co., Niagara Falls, N. Y.; J. W. Paxson Co., Philadelphia, and the W. W. Sly Mfg. Co., Cleveland.



A PORTION OF THE MOLDING MACHINE AND SAND BLAST EXHIBITS IN MACHINERY HALL EXTENSION

Sand Handling Apparatus

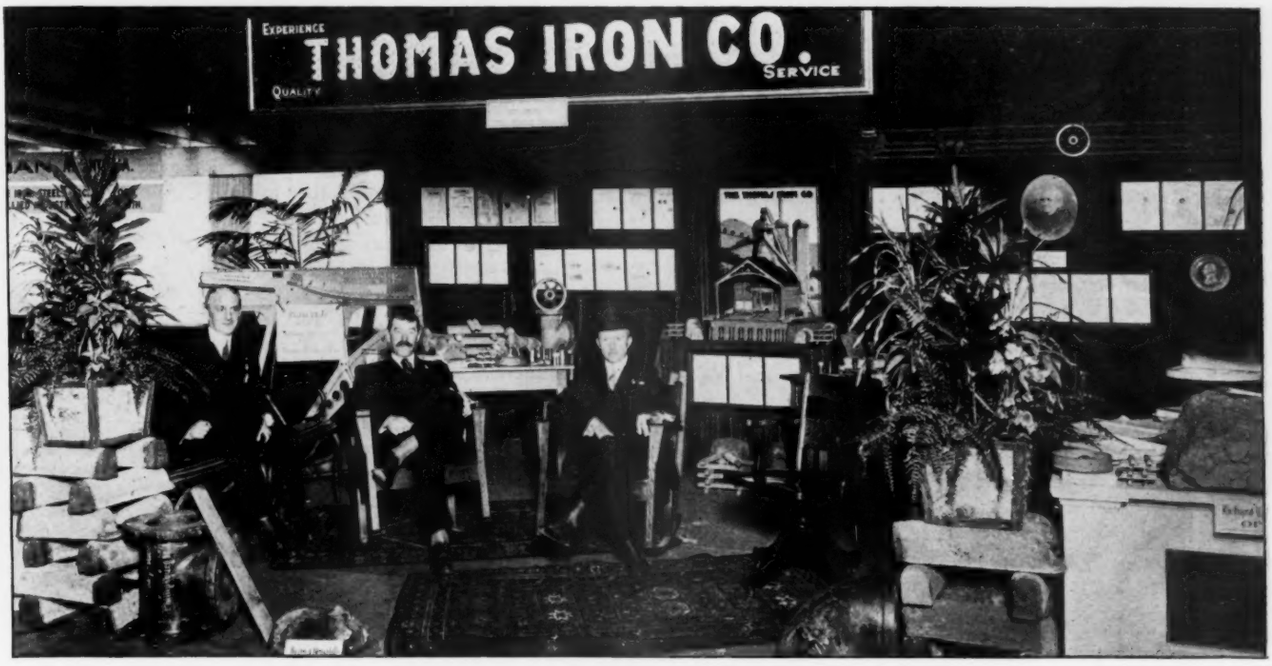
The Hayward Co., New York, presented a working display of an improved clamshell bucket provided with chain drive. The Great Western Mfg. Co., Leavenworth, Kan., displayed the improved Combs gyratory riddle described in detail in the September, 1915, issue of *The Foundry*.

A new, low-charging core sand and facing mixer provided with a rotary screen was exhibited by the Blystone Mfg. Co., Cambridge Springs, Pa. It is approximately 11¾ inches lower than the mixer built by this company previously and is, therefore, easier to load. Pneumatic riddles, sand sifters, shakers and other sand handling apparatus also was exhibited by the Brown Specialty Machinery Co., Chicago; Clearfield Machine Shops, Clearfield, Pa.; International Steam Pump Co., New York; National Engineering Co., Chicago; Sand Mixing Machine Co., New York; Standard Sand & Machine Co., Cleveland; W. F. Stodder, Syracuse, N. Y., and the Wyoming Shovel Works, Wyoming, Pa.

Oxy-acetylene welding apparatus was displayed and working demonstrations were made by the Oxweld Acetylene Co., Chicago. The Macleod Co., Cincinnati, also exhibited welding torches, etc. Thermit welding was demonstrated by the Goldschmidt Thermit Co., New York, and interesting electric welding apparatus was exhibited by the General Electric Co., Schenectady, N. Y., the Westinghouse Electric & Mfg. Co., Pittsburgh, and the Lincoln Electric Co., Cleveland. The Westinghouse company fitted up an arc welding room in which a 500-ampere, 75-volt, 800 revolutions per minute outfit was installed; the General Electric Co. also displayed a 300-ampere arc welder of the carbon and metallic electrode type. All arc welding exhibitors made working demonstrations.

Extensive air compressor exhibits were provided by a number of well-known companies and several of the compressors were in operation, furnishing other exhibitors with air. It is evident that the growing use of electric power in foundries is not operating to curtail the consumption of compressed air. On the contrary, the demand for air keeps pace with that for more kilowatts. Among the exhibitors of compressors and pneumatic tools were the Cleveland Pneumatic Tool Co., Cleveland; Ingersoll-Rand Co., New York; International Steam Pump Co., New York; the Sullivan Machinery Co., Chicago, and the Union Steam Pump Co., Battle Creek, Mich. The latter showed several foundry type compressors which were provided with glass cover plates to show their interior construction.

Rogers, Brown & Co., Cincinnati, showed their excellent series of moving pictures covering the manufacture of iron and steel, well known to foundrymen under the name, "From Mine to Molder."



INTERESTING CASTINGS WERE DISPLAYED BY THE THOMAS IRON CO.

Pig Iron and Coke

An exceedingly attractive display was provided by the Thomas Iron Co., Easton, Pa. An illuminated panorama of a blast furnace cast, was presented, together with castings manufactured from Thomas vanadium pig iron, including piano plates and other interesting pieces. Reprints of advertisements of Thomas iron that have appeared during the past year in *The Iron Trade Review* and *The Foundry* also were presented.

Pickands-Brown & Co., Chicago, presented a very handsome exhibit of Solvay coke. The coke was artistically arranged to form a representation of the Liberty Bell, about 12 feet high. The bell was flanked by revolutionary American flags. An interesting display of coke and by-products also was made by the Lehigh Coke Co., South Bethlehem, Pa. A coke display was presented by the Graceton Coke Co., Graceton, Ind.

Foundry supplies in great variety were shown by the Buckeye Products Co., Cincinnati; Herold Bros. Co., Cleveland; Hill & Griffith Co., Cincinnati; J. S. McCormick Co., Pittsburgh; S. Obermayer Co., Chicago; J. W. Paxson Co., Philadelphia; Robeson Process Co., New York; Sterling Wheelbarrow Co., Milwaukee; United States Graphite Co., Saginaw, Mich.; Waterbury Welding Co., Waterbury, Conn.; E. J. Woodison Co., Detroit, and the Wyoming Shovel Works, Wyoming, Pa.

Samples of brass ingots, bronze and alloys were displayed by the Ajax Metal Co., Philadelphia; S. Birkenstein & Sons, Chicago; Cataract Refining & Mfg. Co., Buffalo; Titanium Alloy Mfg. Co., Niagara Falls, N. Y.; White & Bro., Philadelphia, and the Foundry Manganese Co., Philadelphia.

Safety shoes, goggles, etc., for foundrymen and others were exhibited by F. A. Hardy & Co., New York; Julius King Optical Co., New York; R. P. Smith & Sons Co., Chicago; Safety First Shoe Co., Boston; Strong-Kennard & Nutt Co., Cleveland, and T. A. Willson & Co., Reading, Pa. The extent, variety and excellence of these displays reflected a tremendous interest in safety devices. Manufacturers are no longer satisfied with goggles of an indiscriminate character, but

on the contrary prescribe rigid specifications that must be adhered to.

Wood block floors were displayed by the Ayer & Lord Tie Co., Chicago and Jennison-Wright Co., Toledo. An adding and calculating machine was shown by the Felt & Tarrant Mfg. Co., Chicago. David Lupton's Sons Co., Philadelphia, exhibited a complete line of products for lighting and ventilating. Pattern shop lumber was shown by the Thos. E. Coale Lumber Co., Philadelphia. The Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., made an interesting display of cranes, hoists and trolleys.

The display of machine tools fell short of expectations because all available stock and exhibition machines have long since been exported to Europe or sold to American manufacturers of war munitions and practically every manufacturer is obliged to concentrate his entire energies on the problem of keeping up deliveries.

Nevertheless some very attractive machine tool exhibits were made, prominent among which was that of the Cleveland Automatic Machine Co., Cleveland, which showed a motor-driven 2½-inch full automatic turning machine in operation on large rounds. This machine has a great variety of speeds in both directions. Interesting types of grinding machinery were presented by the Gardner Machine Co., Beloit, Wis., the Norton Co., Worcester, Mass., and Chas. H. Besly & Co., Chicago. The latter showed sanders suitable for use in pattern shops. Other exhibitors of machine tools and machine shop equipment included E. C. Atkins & Co., Indianapolis; Athol Machine Co., Athol, Mass.; Clark Foundry Co., Rumford, Me.; Clipper Belt Lacer Co., Grand Rapids, Mich.; Cowan Truck Co., Holyoke, Mass.; Landis Tool Co., Waynesboro, Pa.; Norma Co. of America, New York; Ready Tool Co., Bridgeport, Conn.; Simonds Mfg. Co., Fitchburg, Mass.; Challenge Machine Co., Philadelphia; Rock Island Mfg. Co., Rock Island, Ill., and the Tabor Mfg. Co., Philadelphia.

The extensive character of the exhibits, the attendance and the volume of business transacted all testified to the return of normal business conditions in the United States. Little apprehension was manifested over the war and it was the concensus of opinion of those in attendance that this country is entering upon a prolonged period of prosperity.

Edison and the Incandescent Lamp

EDISON DAY, October 21, commemorates the thirty-sixth anniversary of the invention of the electric incandescent lamp and honors its master inventor, Thomas A. Edison.

This was even before Edison had successfully determined and chosen carbonized bamboo, the only substance used for about 10 years in making filaments for commercial lamps, which was followed by the "squirted" filament employing carbonized cellulose in one form or another, next the metalized carbon filament, then the pressed tungsten filament, and finally the special form of drawn tungsten wire used in modern Edison Mazda lamps. Working down from a consumption of 4 or 5 watts of electrical energy per candle power in Edison carbon filament lamps to the standard a few years ago of 3.10 watts per candlepower, the Mazda lamp has brought this down in about five years to about one watt; while in the larger sizes of Mazda gas-filled lamps, the reduction in current consumption has reached the low level of nearly a half-watt per candlepower.

Edison practically began his experiments in electric lighting in September, 1878. Just previous to this he had returned from a visit to a Connecticut factory where an electric arc lamp was used, which concentrated his thoughts on lighting by electricity.

The task before the young inventor involved commercially: first, the production of a pure, steady and reliable light from electricity; second, producing it so cheaply that it could compete with gas for general illumination. The electrical problems presented constituted: first, a dynamo of low resistance armature; second, a high resistance lamp, of relatively low candlepower; and third, a distributing system on which the lamps would be connected in multiple instead of in series. These ideas were revolutionary.

Of the two systems before him, the voltaic arc and the incandescence, Edison wisely chose the latter as the practical one for the subdivision of electric lighting into little units. The discovery of the proper substance and method for securing the incandescence proved the sticker. The practical filament was finally found in the fiber growing just under the outside hard surface of a certain bamboo.

Metal Filament

Edison also did a great deal of work with metal filaments, similar to those used at present. Among the early metals experimented with considerably was platinum and alloys. Prominent among the difficulties encountered was the liability of platinum, when that metal was tried, to melt under the intense heat of the electric current, and the tendency of carbon, when employed, gradually to become dissipated under the combined action of gases and the electric current. He tried regulating the current with platinum through levers and diaphragms, but the expansion and contraction of the platinum destroyed the fine adjustment of these devices and they became worthless. Many forms of spirals of platinum and alloys were tried, also osmium-iridium, from which he obtained some success. But Edison found that when metallic conductors that fuse at high temperature are exposed to a high temperature near their melting point in air for several hours by passing a current of electricty through them and then allowed to cool, the metal is found to be ruptured, and under the microscope are revealed myriads of cracks, many of which reach nearly to the center of the wire. They also lose weight. These faults lowered their resistance and were fatal to their lasting qualities.

It seemed then that all his work so far had been futile, but success grew out of failure. This very thing induced him to attempt intercepting the deteriorating effect of atmospheric action, which resulted in the vacuum bulb. Coincident with this discovery it dawned upon him that it was necessary to employ substances with high ohmic resistance for filaments to improve the quality of the light. And so the first commercial carbon filament lamps were evolved, and later through various stages of research the other improved types up to the present modern Edison Mazda lamps.

The next great problem that Edison attacked was a system of distribution. Prior to 1880 there was no method known by which large numbers of electric lights of a power about equal to a gas burner could be operated practically over large areas.

Edison paved the way to original scientific investigation in the lighting field, and this work is all being carried on in the research laboratories of the General Electric Co., Schenectady, N. Y. The technical skill employed to improve constantly electric lamps and lighting, embraces every phase of associated invention, design and manufacture. Practically every branch of science and engineering is represented in this great work of experimentation, testing and development.

Training in Foundry Work That is Worth While

The Course at the University of Illinois Which Embraces the Science of Management as Well as the Practice of Casting Metals

By R E Kennedy and J H Hogue

DURING the last few years there has been much discussion among the employers of technical graduates and those men who are at the head of the administration of the technical courses in the colleges and universities, as to the value of the training in shop practice given to the undergraduate student.

The purpose of these courses, when first started almost 40 years ago, was to give the college course an air of practicality and afford the student some training in the elementary principles of shop work. Very few of the students entering the technical schools then had any acquaintance with shop principles and methods of manufacture, and it was necessary first to instill in their minds a knowledge of the elementary shop practices.

Because of the recent advance in trade and manual training teaching in the secondary schools, and the changing demand of the employers of technical graduates, the question as to the advisability of changing, or entirely abandoning the work has arisen, and it has become a vital problem to the schools concerned.

The question was aptly stated by Dr. W. F. M. Goss, past president of the American Society of Mechanical Engineers, when he said "The time has come when the shop laboratory should cease to be content with a grade of work possible in a secondary school; its work should possess a quality and character which is only possible in the environment of the technical school. This implies that the work of the shop laboratories must be interrelated with that of other technical courses, that such laboratories must cease to use equipment which was purchased one or two decades ago, and that they must cease to be satisfied with methods of administration which, in actual shops, have already passed out of existence. If the shops are to mean anything worth while, they must not only respond to the great and significant changes which have been going on outside, but they must have their part in leading such changes. Their work must not stop with the routine; it must proceed to the development of research that new principles may be established."

With this problem before them, those in charge of the shop work at the University of Illinois set about reorganizing the work and putting it on a basis where the student would derive the greatest benefit. Thus, not merely to develop skill in hand manipulation, but to develop those qualities needed in the executive rather than those needed by the molder, was the problem to be solved.

To do this, the nature of the work had to be changed from mere teaching of manual training to instruction work showing the principles of modern shop organization.

As the main object of the whole course in shop laboratory work is to teach the engineering students the prin-

A paper read at the twentieth annual meeting of the American Foundrymen's Association, Atlantic City, N. J., Sept. 28-Oct. 1. The authors, R. E. Kennedy and J. H. Hogue, are instructors in foundry and shop practice, University of Illinois.

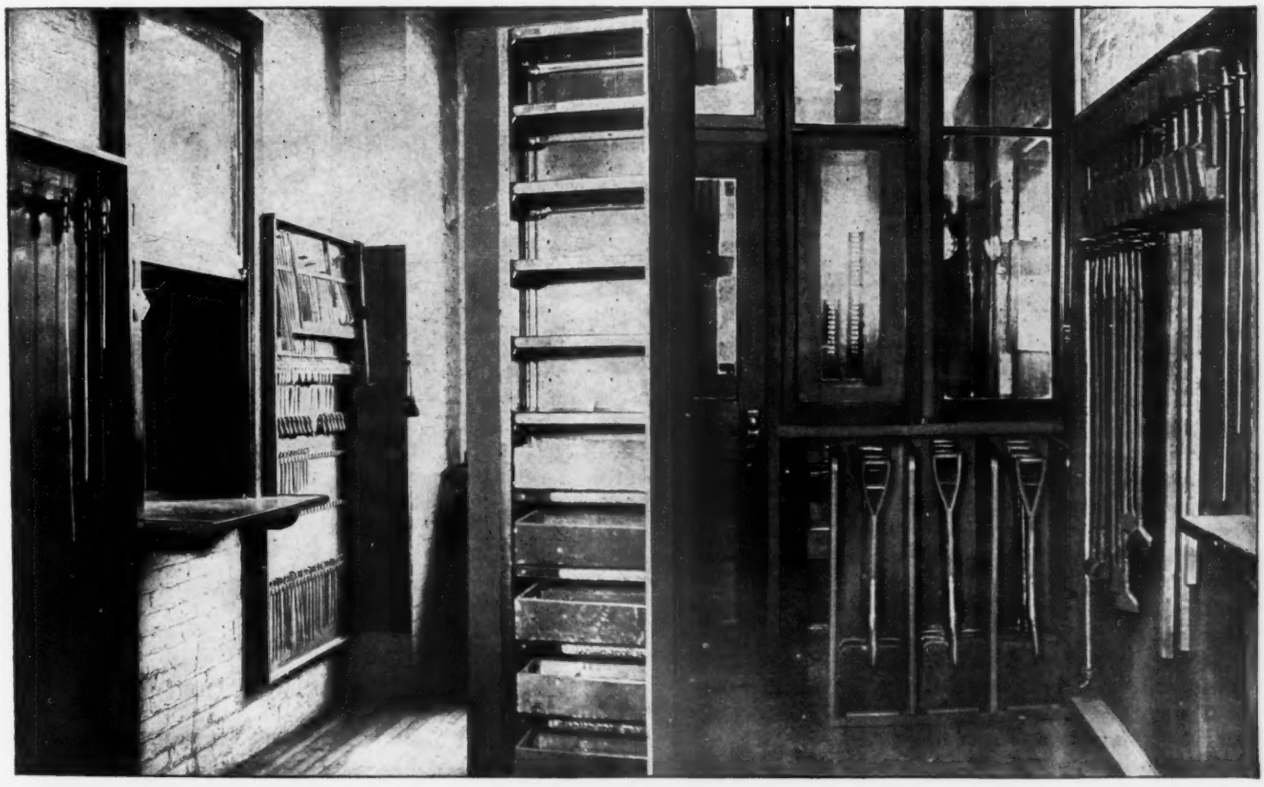


FIG. 1—A TOOL ROOM FROM WHICH THE WORKMEN CAN OBTAIN THE RIGHT TOOL WHEN NEEDED IS A PAYING INVESTMENT FOR ANY PLANT

ciples of shop organization, the foundry and other departments of the shop laboratories were reorganized on a commercial basis. A number of standard products were adopted for regular manufacture, among which was a two-cylinder, eight horsepower gasoline engine. This engine was the first product developed and standardized.

Orders are issued from the director's office for the erecting of a given number of engines and each department receives its individual order for the parts which it must manufacture.

The method of instruction pursued in the departments of the shop laboratories necessary to carry out this plan can be explained by describing the work as fix the method firmly in their minds. It has proved to be a fact that the more time spent in demonstration, while reducing the actual working time of the student, has resulted in an increase in the production of castings.

In addition to the reading of notes on foundry practice, the students subscribe to one of the leading foundry magazines and study the articles and advertisements. This gives them an insight into the methods used in the most modern shops and makes them familiar with the problems foundrymen are encountering in their work.

These demonstrations and practice periods so cover the work that when they have been completed, the students functions performed by the staff assistants may be noted in the chart, Fig. 12. To show the work accomplished, the duties of each assistant will be considered in detail.

The production assistant has charge of the shop production, including the working forces and shop equipment. He is responsible for shop output.

As the orders for castings are received, he enters these on his production sheet and announces the schedule for producing these castings. He issues the necessary work orders in their proper order; that is, he first orders the preparing of the material for cores, if cores are to be used, then when this is ready, he issues the orders for mak-

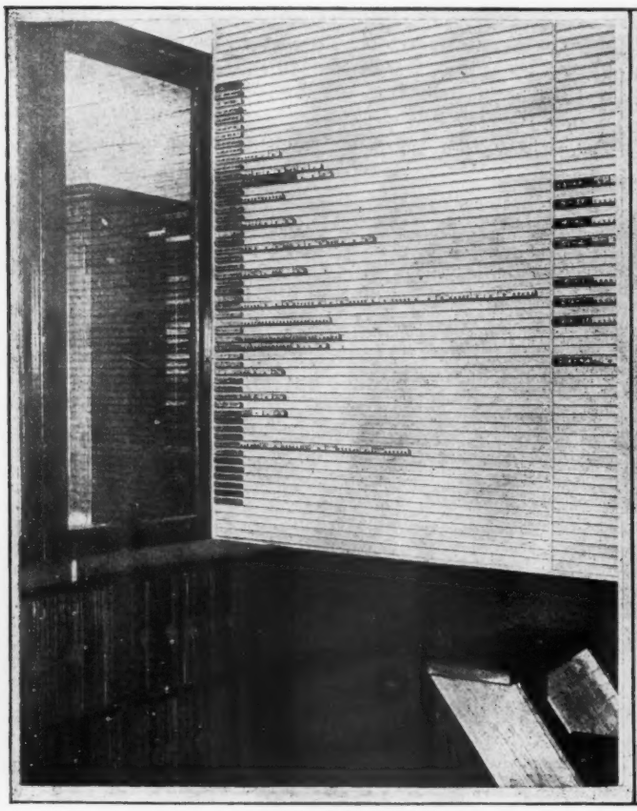


FIG. 2—WORK SCHEDULE BOARD
The staff assistant's office should be a place where is gathered all the information needed for the planning of work and scheduling its progress through the shop

FIG. 3—WOOD MILLING MACHINE COLUMN CASTING, SHOWING THE VARIATION OF WORK IN THE SHOP LABORATORIES

followed in the foundry, with a description of the foundry mechanical equipment. All departments, machine, pattern, forge and foundry, are working on the same general plan, although each has its own distinct problems of production, mechanical efficiency and organization.

The preliminary work of instruction in foundry work is covered by a series of demonstrations and lectures on the essential features of bench and floor molding, coremaking and cupola practice. Immediately after a demonstration of one feature of the work has been made, the students are given some time in which to do the actual work and thus can be organized into shop forces, and with the proper supervision carry on the work of a producing foundry.

With this organization, the students are divided into two general groups:

1.—Staff assistants or executives.
2.—Producing force.

The staff assistants are six in number:

A.—Production.
B.—Materials.
C.—Mechanical.
D.—Standard practice.
E.—Accounting.
F.—Experimental.

The producing force is divided into the usual groups of

A.—Molders.
B.—Coremakers.
C.—Cupola operators.
D.—Cleaning force.

The general plan and relation of the ing the cores. When the cores are on the stock shelves, the work order to the molder is issued. A work schedule board, Fig. 2, has been placed in the office of the production assistant: on this is kept a record of the progress of the work. The work posted on this board is that which should be turned out in one week.

All foundry operations on regular products are standardized and definite instructions are issued in the form of instruction cards, Fig. 6, for the making of each core, core wire, mold, the mixing of core sand and cupola work. These cards contain all the necessary information relative to the production

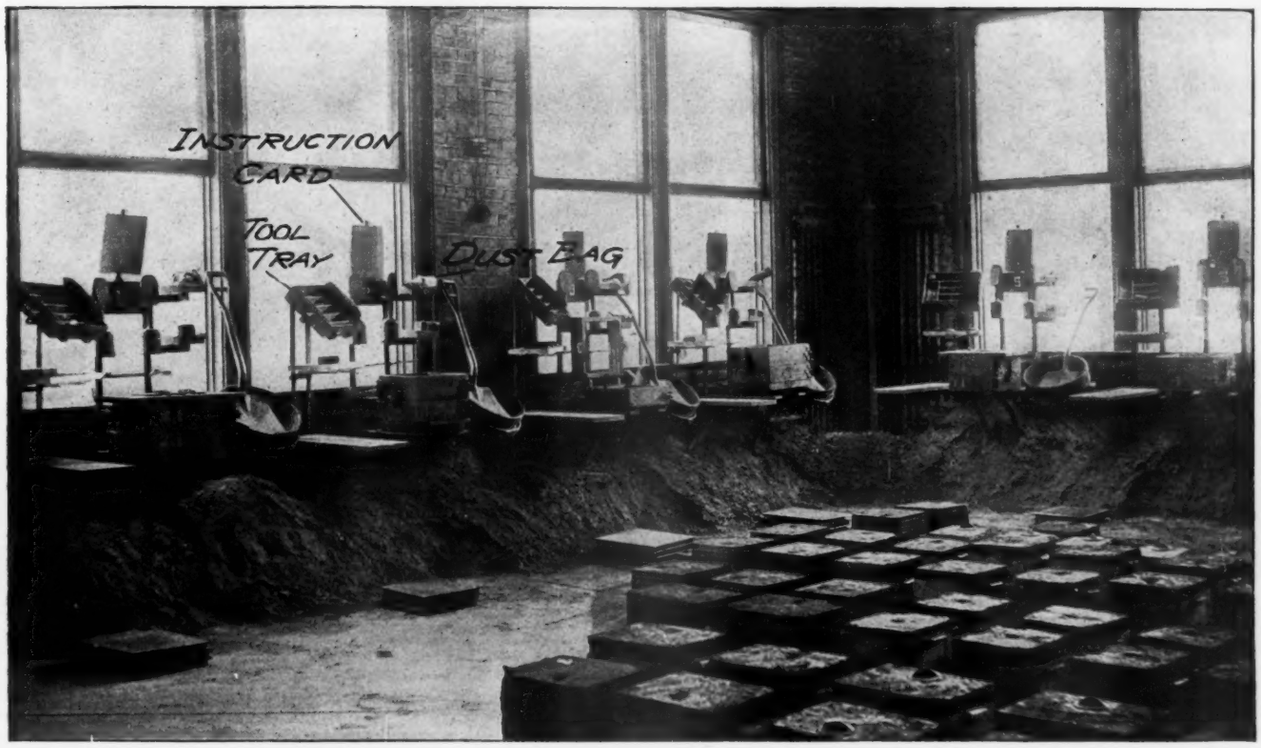


FIG. 4—MUCH CAN BE DONE BY MOLDERS TO SO ARRANGE THEIR TOOLS THAT A MINIMUM AMOUNT OF TIME NEED BE SPENT IN REACHING AND PLACING THEM

of that piece of work. In the case of a mold, it has the size of flask to be used, the tools needed, the cores used, the place where it is to be worked, an operation routine, and a standard time, which is the time in which the piece should be made if no waste effort occurs. This work of making instruction cards is performed by students, in the manner described later under the heading of *Standard Practice Assistant.*

With this detailed information, the production assistant knows in what order the work should be made and how long it should take. The progress board, when filled out, then is before the assistant as a picture of the way his work is being performed. For each pattern to be used there is placed in the grooves of the board a block on which the pattern number is stamped.

FIG. 5—CORE RACK WHERE THE SETS OF CORES ARE ASSEMBLED FOR THE MOLDERS

Other blocks which indicate the different core and molding operations are placed in the same groove. As the cores are made, this information is sent to the production office and colored tacks are placed in the blocks which indicate the state of work on that particular operation. With the information of this board before him, the production assistant can intelligently issue work orders for the making of molds and cores.

He then gives to the materials and mechanical assistants the information as to when and where these cores or molds are to be made and they oversee the preparation so that when the molder or coremaker receives his work order cleaning of castings, shifting his forces around to suit the needs of the work to be done. The standardization of such work as mixing core sands and cupola preparations, has proved to be an important factor of success in this work of getting good product from comparatively inexperienced workmen. This same principle of standardization of materials could be employed to great advantage by many foundries which are at present doing the work by the old *hit-or-miss method.*

Advantages of System are Obvious

The workmen, having finished their task, stamp-out on their work order cards and are given another work order, of the shop or bettering the quality of the work. From these notes, he writes a report on conditions and gives his recommendations for improvements.

These reports are discussed and it is considered that the training derived from the making and discussion of them is one of the most beneficial results of the work in the shop laboratories.

The material assistant performs the duties as outlined on the chart, Fig. 12. These duties, in detail, include the keeping of inventory records of materials, which outline the maximum and minimum quantities of materials to be kept on hand for use in the foundry. By the use of the record sheet, the assistant, at any time, has a knowledge of the

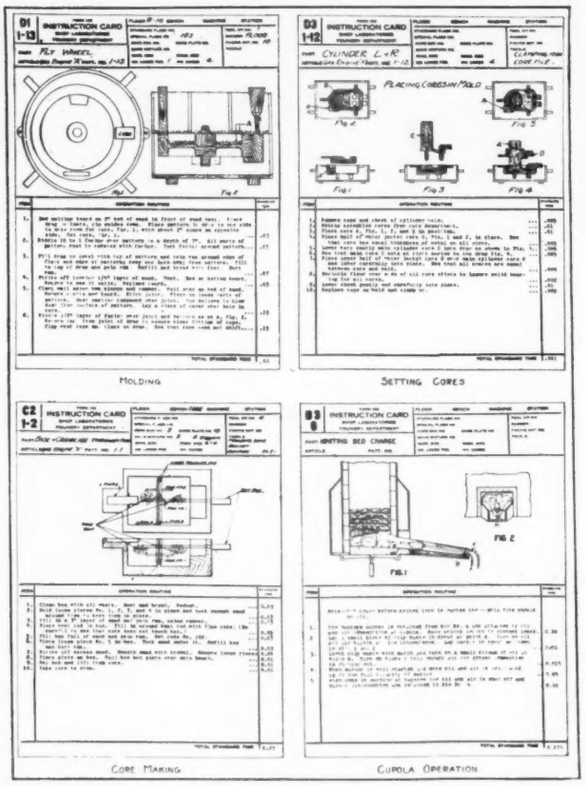


FIG. 6—THE INSTRUCTION CARDS SHOW HOW THE WORK IS TO BE PERFORMED

FORM 7
UNIVERSITY OF ILLINOIS
SHOP LABORATORIES

RECORD OF TIME STUDY

DEPT.

OPERATION Core Making
ARTICLE Piston Pattern 1 - 24
INSTRUCTION CARD NO. C 1, 1 - 24 OPER NO 1
OPERATOR'S NAME Sundell, H. A. NO. 24 SEC A
DATE 9/5 1914 TIME STUDY NO. 2

ITEM	DETAILS OF OPERATION	TIME ACTUAL	TIME LOST	TIME PROPOSED	EXPLANATION OF OPERATING TIME LOSSES
1	Placing plate on bench	.03	.02	.01	Could not locate right plate at once
2	Cleaning box	.04	.03	.01	Had been using sand too wet.
3	Place box in position. Assemble	.01		.01	
4	Ram first layer of sand. Set rods.	.05	.04	.01	Rods cut too long. Had to exchange
5	Set 2 loose pieces of box	.01		.01	
6	Fill box and ram. Strike off.	.04		.04	
7	Remove loose pieces. Fill with molding sand	.02	.02		Use of iron dryers would eliminate this item
8	Clamp box. Roll box over on plate	.02	.01	.01	Clamps loose
9	Rap box, and lift	.01		.01	
10	Patching torn corner	.04	.04	.00	Box needs repairing. Send to pattern shop.
11	Blackening	.05	.02	.03	Core maker used a very small brush
12	Carrying to oven	.07	.05	.02	Had to wait for helper
	TOTALS	.39	.23	.16	

INVESTIGATED BY: _____ STUDY MADE BY: Pope, G. H.
WORK SCHEDULE ENGINEER — WORK SCHEDULE ASSISTANT

FIG. 7—RECORD OF TIME STUDY
A time study of a simple operation often brings to light many things to be corrected in the shop practice.

card, he proceeds to the assigned place and finds everything in readiness for the production of the cores or molds, so that he can devote his whole energy to the actual work of coremaking or molding.

As the castings are poured, sent to the cleaning room and then delivered, this information is recorded on the board so that the production assistant can at all times tell the stage of progress of each casting. This information is brought to the production office by the inspector who keeps track of the cores and molds made and of the good and bad castings poured, cleaned and delivered. The production assistant also has charge of the operation of the cupola and and when they proceed to this work they should find their materials and tools waiting for them.

This method of work forcibly impresses on the student the benefits to be derived from a well-defined plan of knowing how the work is to be done, where it is to be made and when, showing the difference between planning the work in advance and attacking the same without consideration as to methods to be used.

The production assistant, during the time he is holding that position, makes notes of all conditions of shop operation or methods coming under his supervision, which may be changed or eliminated, thereby increasing the efficiency amount of stock on hand, and when this stock is reduced to the minimum quantity, he orders a new supply. In ordering he obtains his information as to specifications from the record sheet on which is outlined the place of purchase, analysis or quality, etc. From the production assistant the materials assistant receives a record of the molds and cores to be made, where they are to be made and when. With this information in hand, it is his duty to see that the molders have all their supplies brought to them, such as cores, graphite, parting compound, nails, etc. He has charge of the mixing of the core sands cutting of core wires and rods and these he supplies to the coremakers

FIG. 8—BRASS FURNACE AND FLOOR OF BRASS MOLDS

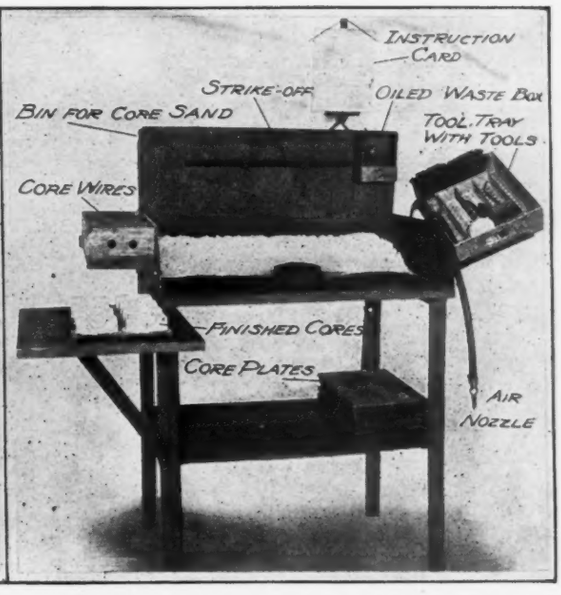


FIG. 9—THIS CORE BENCH ARRANGEMENT ALLOWS THE COREMAKERS TO TURN OUT A LARGE AMOUNT OF WORK IN A GIVEN TIME

when needed. The instruction cards indicate the kind of core sand needed for each core and these sands are mixed according to the standard prepared, eliminating the usual guessing as to the amounts of sand, binder and water.

The materials assistant's work puts before the student the importance of knowing the amount of stock on hand, the danger of having materials out of stock, the loss in money to the plant when keeping in stock such large supplies of certain materials because the information as to the amount used in a given period of time is not known.

The duties of the mechanical assistant consist of the maintenance, in an efficient condition, of all shop tools, machinery and equipment. He has charge of the tool room and is its attendant, over-seeing the care of the tools kept in this tool room. He has on record a list of all tools, with the condition in which each tool must be kept to be efficient. This record is called the tool standard and tells when to repair or to discard and replace tools. It is his duty to oversee the oiling of machinery, repairing broken parts, or recommending the purchase of new equipment. The flask upkeep comes under his supervision and he sees that the flasks and boards are repaired or replaced. Similarly to the materials assistant, the mechanical assistant receives the notice of molds and cores to be made and he prepares the tools and mechanical equipment needed. It is his duty to keep the molders supplied with the right flasks, boards and tools. The coremaker is furnished with the plates needed and necessary tools for the job to be worked.

For the mechanical assistant to know what tools are needed, he must consult the instruction card, on which is recorded all tools, size and kind of flasks, plates, or machines needed for the work.

By the co-operation of these three assistants, the work is all planned in advance, eliminating the trouble so often encountered, when, without planning, a job is started, and then an endless succession of delays are met, with the consequent loss of several men's time while waiting for flasks to be brought in, cores to be hunted, tools needed but not to be found, and many more difficulties of the same kind.

This brings to the students' attention the value of planning and preparation in a real, practical demonstration. They

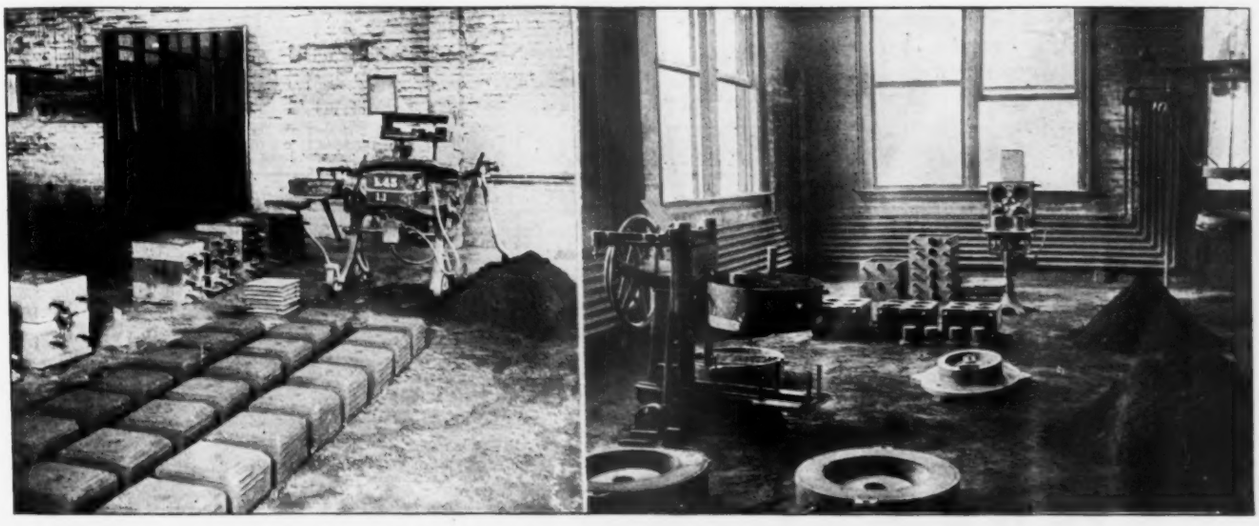


FIG. 10—THE ADVANTAGES TO BE GAINED BY THE USE OF THE DIFFERENT TYPES OF MOLDING MACHINES ARE TAUGHT TO THE ENGINEERING STUDENTS

see, when they do not perform their part, the consequent loss of time of the other men and the result is more thoroughly impressed on their minds than by any other method.

The work of the standard practice assistant, as the title indicates, involves the work of standardizing the shop practices, the method of operation routines and the materials and tools used. To obtain standards on core sands, facing mixtures and cupola relining mixtures, the students make a study of the qualities of different mixtures, comparing their qualities with each other. The proportions of binder and sand, the amounts of water, the routine of mixing and time of baking are recorded. In this manner the best core sand mixtures for the various types of cores are found. This information is then recorded on an instruction card and when this mixture is needed the card is used by the materials assistant in preparing this sand for the coremakers. The standard operation routines and times set on the instruction cards of the types shown in Fig. 6, are obtained by making a detailed time and motion study analysis of different men working on the same piece of work. Care is taken to study the job to discover the best operation routine and the time needed to perform the necessary routine items, while the necessary tools and materials are listed.

The studies being completed, any helpful sketch is placed on the card, the operation routine written and then blue prints are made from the tracing. The prints are pasted on heavy cards and filed away in the staff assistant's office to be issued as needed by the workmen.

This is the treatment for all standard work. For miscellaneous work, a temporary instruction card is written, giving the estimated time and other information required, such as position of gates, venting, setting of cores, etc.

Therefore, a finished instruction card not only tells the workman how to do a piece of work, but it gives the assistants the information necessary to prepare all tools and materials and it tells the production assistant how long a given piece of work should take and the order of operation routine.

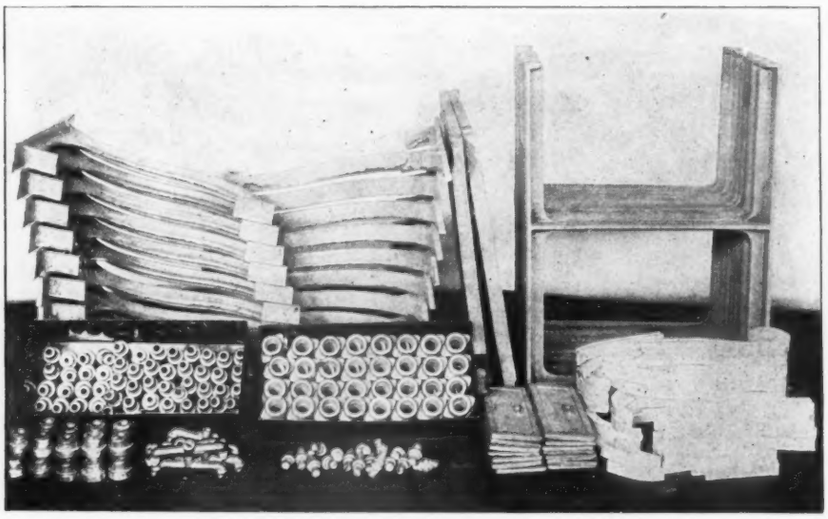


FIG. 11—SMALL IRON, BRASS AND ALUMINUM CASTINGS MADE BY STUDENTS DURING THEIR FIRST WEEK'S SHOP WORK

This work of investigation and time study has proven to be of more value to the students than any other work they perform, as they find that because certain work has always been performed in a certain way in the past is no reason why it should continue to be made that way. The student is always keeping before him the idea that probably there is a better way of doing the work and that he should make the most thorough study possible to determine the most efficient way. This is training the student to think and analyze working conditions for himself. Due to the nature of manufacturing work there are always new mechanical problems to be investigated and solved. These are slowly solved in ordinary plants by men whose time is supposed to be spent in the regular work of production. The best equipped and most modern concerns have specially trained men in a separate department whose sole duty it is to investigate and test new methods, machines and materials. The foundry has an unlimited number of such problems and the experimental assistants are given lectures on some of these possibilities, and are then set to work on particular problems relating to this shop. Experiments and tests are made by the students on such subjects as metal mixtures for brass and iron castings, cupola refractories, core sand binders and sands, and on labor saving machines. By carefully analyzing the results of the tests and recording the data obtained, much benefit is gained in the performance of this work.

The work of the accounting assistant includes the care of the inventory records, recording the labor and materials cost on the different orders, and assigning overhead charges to these orders. He obtains the labor cost from the work order cards, and the materials cost from the information records of the materials assistant.

All the staff assistants make a report on the conditions that come under their observation, which they think can be bettered and their methods for the accomplishment of these changes are set forth in this report. While the introduction of shop management principles is the main object of the work, the use of a well planned layout of shop equipment has been emphasized and many novel features have been worked out, which could be installed with profit by many shops.

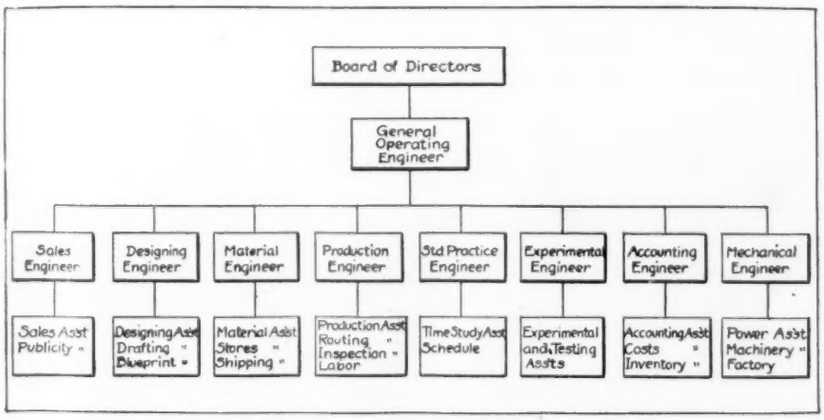


FIG. 12—OUTLINE OF THE OPERATING ORGANIZATION OF THE SHOP LABORATORIES

The specialization of the executive work is as necessary in any manufacturing plant as the specialization of the duties of the workman

A need was felt for a well-equipped tool room in which to store the small tools, commonly used in a foundry. One

of the greatest sources of lost time in foundry operation is caused by the workman not having the proper tool and he either does the work with a less efficient tool, or if the proper tool is supposed to be around, he will spend a long time hunting it. The workman will seldom supply himself with a full set of tools, because some are needed so seldom that he thinks he can get along without them. But there are times when he needs one or more of these and he does not have them. This tool room, shown in Fig. 1, also provides a storage place for riddles, rammers and shovels, which, as a general rule, have to stand all kind of abuse because no definite storage place is provided.

How Tools Are Maintained

The tool trays stored in the tool room are filled with sets of tools called for on the instruction cards and these are set on the molding and core benches as shown in Figs. 4 and 9. Odd tools are checked out by the workmen on the ordinary brass check system. When these tools are returned they are inspected by the tool room attendant, and any needing repair or replacing are set aside and turned over to the mechanical assistant.

Two of the biggest labor-saving devices designed and put into use in this shop are the molding and core benches shown in Figs. 4 and 9. These benches were designed with a view of having a place for every necessary tool and all materials, and to have each thing within the easiest reaching distance, and a most convenient place for replacing. By this arrangement and the following of the standard operation routines, practically all of the waste or lost effort, so common in bench molding and coremaking, is eliminated.

The principle of the arrangement of the core benches, Fig. 9, is similar to that of the molding benches. The hopper holds a large quantity of sand, thus allowing a large amount to be delivered to the bench at one time and yet to prevent it from being spread out in the way of the workman. The standard tool tray is placed at the right for convenience in reaching the tools. Being tilted, the tools can be easily seen and reached. At the left is the wire and rod box, off the working surface of the bench, yet easily reached.

These boxes of bent wires are brought from the stock room as ordered by the materials assistant. The empty plates are stacked on the lower shelf of the bench, while the small side shelf is used as a support for the core plate when being filled.

For cleaning the core boxes there is a waste holder for holding the kerosene-soaked waste with which to clean the box, and a compressed air hose with an attached blow gun for blowing out the dirt. The strike-off has its holder on the sand hopper directly in front of the worker. Easy of access, it can be replaced by throwing it into place. The instruction card holder is so placed that the card can be easily read by the worker.

By this arrangement of the bench, the coremaker has and keeps each thing in its place and loses no time in hunting for the tools, plate or wires needed. His whole time, for this reason, can be devoted to doing the actual productive work of coremaking.

The oven equipment consists of one large truck oven, heated with an oil burner, and one portable, gas-fired oven. When the small cores are taken out of the oven they are set on the nearby cooling shelves of the rack, shown in Fig. 5. The upper shelves are devoted to stock core storage. As the orders are made up for the different molders, the cores are placed on trays, shown on the molding benches, Fig. 4, and are taken by the materials assistant to the molding benches or floors when they are to be used.

Patterns Fitted for Squeezers

Some of the machines in use are shown in Fig. 10. The greater percentage of the standard patterns are fitted up for squeezer machine work, although the flywheels, pistons and similar work, are made on the stripping plate and roll-over machines.

The melting equipment consists of two Whiting cupolas and a Hawley-Schwartz brass furnace. A 5-ton Whiting crane commands the entire molding floor space. Figs. 11 and 3 show some of the large and small work which can be turned out by the students after a short period of instructions if the work is administered in the most efficient way.

The ideal of the instructional work is to convey on the student a knowledge of the best methods of foundry practice, to give him the ability to distinguish between good and bad practice, and to instill in his mind the methods used to investigate shop performances.

Shrinkage Cracks in Steel Castings

By William R Bossinger

SHRINKAGE cracks in steel castings constitute a common defect of steel foundry operations. The cause of shrinkage cracks is the same for all castings, but their locations are never identical, owing to the varying forms of different sections. It is not unusual to make castings from one pattern for a period of several months without being troubled by this defect, yet suddenly all of the castings from one heat will develop these cracks. If it were possible to prevent steel from expanding or contracting, this difficulty would be overcome, but since this is beyond control, the alternative must be accepted and this phenomenon must be contended with, namely, the contraction of the steel after the mold is filled. To reduce these defects or to eliminate them entirely, every effort should be made to prevent setting up solid walls that will cause the metal either to stretch or crack when the force of contraction is brought to bear on the walls of the molds.

Numerous appliances, devices, etc., are resorted to to overcome this defect, including the use of brackets, chills, tie bars, the use of sawdust or cinders in the cores, maintaining the metal at a minimum temperature when pouring and keeping it as low in sulphur as possible, as too high a percentage of the latter element is one of the common causes leading to shrinkage cracks. Long castings with attached ribs, flanges or lugs will crack if the sulphur is not well under 0.05 per cent in basic steel, regardless of the fact that other properties and conditions may be favorable to the elimination of this defect. While the various causes leading to shrinkage cracks are well-known to the management of steel foundries, nevertheless this will not eliminate losses from this cause until a knowledge of the cause of shrinkage cracks is imparted to all of the men constituting the organization. The success in keeping down shrinkage cracks is based upon the training of the men who are directly responsible for the development of this defect. Each casting presents a different problem, as the thickness of metal and the lack of uniformity in section will change the location of these cracks in one

A paper read at the annual convention of the American Foundrymen's Association, Atlantic City, N. J., Sept. 28-Oct. 1.

casting as compared with another of an entirely different form. To train the shop force in eliminating difficulties from this cause, the common sense of the employes is a contributing factor of no little importance. Theory and practice combined, as well as previous experience, likewise should be taken into consideration. It is not unusual to stop cracking in one part of a casting, only to have this defect develop in another part of the same piece. This, however, should not prove discouraging, as it indicates that proper methods are being taken to prevent these defects. The law of the segregation of metals should be recognized as being closely allied to the causes underlying the formation of shrinkage cracks. Segregation will cause the formation of shrinkage cracks on the outside surface of many castings.

The free use of chills is recommended, as they will reduce this defect by controlling the cooling to a greater extent than the use of brackets. Unless efforts are made to prevent the employment of chills that are too large or heavy, or which extend over onto the junction of heavy and light sections, the chills will increase the tendency to crack. If the chill is too large, it will cause shrinkage cracks at the point of the chilled face. This is caused by the too rapid contraction of the casting directly underneath the face of the chill. When the chill is of the proper thickness, it causes the heavy part of the casting to pass through the first stage of contraction, imparting to the metal sufficient strength to meet the stresses caused by passing through the first cooling stage. Stresses in the chilled parts of steel castings are eliminated when the proper chills are employed. The chills will absorb heat from the casting until they reach a temperature of 1,400 degrees Fahr., and on cooling with the casting all stresses should be relieved as the casting strains are released by what practically constitutes annealing at this temperature. The use of chills is resorted to for the purpose of reducing the size of feeders on many castings. The chills are inserted in the molds over lugs and flanges that have light, thin sections on top. A chill should be of sufficient size to set the heavy section of metal before the metal in the lighter section has left its fluid state. In this way fluid steel will be carried to the chilled part and other fluid steel will be drawn from the feeder to replace metal taken from the lighter section. Another reason why the chill is to be favored in place of the use of brackets is that the chill will fall out of the mold when the casting is shaken-out, whereas the brackets have to be chipped off.

Improper gating also is frequently the cause of shrinkage cracks, forming hot spots in line with the flow of metal. If a flat casting is gated in the center and the metal is forced in one direction, causing the sand to absorb and retain heat in this section of the mold, thereby causing a hot spot in the casting resulting in a shrinkage crack, it can be attributed to the remainder of the casting cooling and contracting in advance of the center of the hot section. To further illustrate this point, an I-beam section will be considered, which is gated in the center of the web. If poured in this way, the casting will be liable to crack, as the flanges will resist contraction and the center will be weakened by the higher temperature of the metal due to the method of gating in the web, and this part of the section would lack the strength to withstand contraction and the crushing of the sand walls on the casting's flanges.

Standardizing Air Furnace Practice

By A L Pollard

THE AIR furnace of today has been developed by many years of patient endeavor on the part of malleable founders. It has now reached a stage where improvement either must be very slow and must show year by year diminishing returns in added efficiency, or new methods and materials must be discovered. The scientific study and standardization of what has been already developed, for the most part empirically, will be the guide to the improvements of the future.

The air furnace has survived and has been developed to its present form by reason of its fitness under conditions as they actually are, which, by the way, is the highest reason for the survival of anything. Its inefficiencies may be deplored, but a great deal is asked from it. It must melt quickly, must be not too high in first cost and must in addition, be adaptable to a considerably wide range of capacity. With the data now available, there is no reason why a furnace cannot be constructed which will work exactly the same every day under the same general conditions. The design is the first consideration. One dimension is limited, namely, the width. The furnace must be narrow enough to permit easy skimming as well as to allow the construction of easily supported bungs. This width is approximately 7 feet inside. The design is then confined to six main points, as follows:

1—Length of hearth.
2—Depth of bath.
3—Length of firebox.
4—Height of roof.
5—Opening at neck.
6—Wall thicknesses.

The length of hearth and depth of bath are mutually dependent. To design a furnace of any particular capacity, we may start with an average bath of 6 inches, which will give us quick melting, or of some other depth, such as 10 inches, which will give us slower melting and somewhat colder iron. For average practice the writer recommends a depth of 8 inches. With the tonnage, width and depth given, it is a matter of arithmetic to determine the length of hearth.

The furnace hearth should be deepest just in front of the bridge wall where the heat is most intense, and shallow at the neck where melting is much slower. The tap hole, of course, is located at the deepest point of the hearth.

The grate area is a factor of much importance and is entirely a matter of experience. This area can be determined in two ways. It has been found that the ratio of grate area to hearth area should, generally speaking, be about 1 to 4.

Also, since the melting ratio is 1 to 3 or better under forced draft, and since we should burn about 50 pounds of coal per square foot per hour, we can calculate the area in this way. If we should consider natural draft, we would assume only 30 pounds of coal per square foot per hour and a fuel ratio of 1 to 2½. With forced draft we would obtain a melting speed for a 10-ton furnace of about 4½ hours. Natural draft would be much slower. The roof must be high enough to

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allow free passage of the flame when the furnace is charged with cold-stock. In a 10-ton furnace this will be about 3 feet 6 inches at the deepest point. The roof should be no higher than necessary, as the most effective heating factor is in radiation from it. Also, it has been shown that gases are most effective in heating when moving at a high velocity. Obviously, the lower the roof, the greater this will be. The roof should be as nearly flat as possible, sloping gently down at the back. There is absolutely no advantage in the weirdly curved and indented roofs which some old furnaces have.

The opening at the neck is a point of great importance. It must be just right for successful operation. It is entirely dependent upon the volume of gases passing through the furnace and upon the draft. This opening, in a 10-ton furnace should be about 3 square feet in area, but it should be adjusted as conditions of draft vary to always give a slight back pressure in the furnace. In other words, the total pressure of gases at this point should slightly overbalance the suction from the stack. Of course, in a natural draft furnace, this relation cannot be maintained, and consequently little or no air can be admitted over the bridge wall. The necessity for this back pressure is due to the fact that unless there is an appreciable pressure, a large amount of air is sucked in through the doors and roof, which tends to cool the furnace and greatly lower its efficiency.

The furnace walls may be either 9 or 13 inches in thickness. Thirteen inches is best and most economical. Less heat is conducted through them and at the slag line the inner 4 inches can be removed and replaced without disturbing the entire wall.

The possibilities for improvement in air furnace construction open an interesting subject for speculation. The disadvantages of the furnace may be briefly summarized as follows:

1—Exhausting labor of firing and skimming.
2—Large amount of heat lost in waste gases.
3—Large amount of heat lost through bungs.

The labor of firing has long been a difficult point in air furnace practice. It is difficult to get and keep good firemen. There are only three ways out of this difficulty, considering coal as fuel. One is, utilization of the open hearth furnace with regeneration, which we are not considering here. Another is in the use of automatic stokers. Some furnaces are equipped with these, which are giving satisfaction, but there is opportunity for much improvement. The writer believes that by far the most economical and best method of firing air furnaces is in the use of automatic stokers. A third method is by the use of pulverized fuel. This seems to offer possibilities, but it necessitates a large investment in equipment.

Concerning the heat lost in waste gases, unless we consider the open hearth, there is absolutely no opportunity for improvement in the furnace itself.

In order to attain a melting temperature in the furnace it is necessary that waste gases leave the furnace at that temperature. The waste heat boiler offers a good method of utilizing this lost heat, but this is outside our present discussion.

The heat lost through bungs also is difficult to overcome. Under present practice, where removable bungs are in use, the thickness cannot be much increased, as it is necessary to keep all parts of the brick, through which the resultant pressure line passes, below the softening temperature of the brick used. The only improvement that the writer can suggest is to make the roof permanent and suspend it from one or more points between the skewbacks. This, of course, would necessitate charging from side doors.

Furnace operation starts with the mixture of pig iron, sprue, scrap, etc. This, so long a matter of mystery, is perhaps the simplest part of furnace operation; however, for best results it must be done along scientific lines. Having the analysis of the various materials, knowing what we desire to do, and with data from a few heats showing what elements are oxidized and to what extent, it is then a simple matter to make the mixture. The decision as to the final analysis of the heat is very important. It will depend largely upon the class of work. The writer's opinion is that the proper analysis should be about 2.50 per cent carbon and as much silicon as the heaviest section will carry without precipitating graphite.

The really difficult part of air furnace operation is in burning the proper amount of coal and adjusting the draft. Improper draft is the most frequent cause of failure. This subject is simple in theory, but seems to be difficult in practice. Starting with a properly designed furnace and a certain charge, we can find the amount of coal which should be burned. This amount of coal should then be shoveled in, at frequent intervals. Air enough should be admitted under the grate to burn all the coal with a somewhat smoky flame and air enough should be admitted over the bridge wall to burn the fire box gases with a clear flame. Next, the opening at the neck should be adjusted to give a slight back pressure. The back pressure is right when the flame just tends to shoot out from the furnace openings.

If the malleable business is to be standardized on a basis of high quality we must know exactly what we desire to do and then do it in a thoroughly scientific manner. It is quite possible to have every heat poured of the right analysis and at the right temperature and this should be our constant aim. Proper annealing is so difficult that we cannot afford to complicate it by poor furnace operation.

Checker Design for Open-Hearths

By W A Janssen

ALMOST simultaneous with the announcement of the discovery of making steel by the converter process by Sir Henry Bessemer, in 1856, the Martin brothers, in France, were attempting to make steel in a reverberatory furnace. Their efforts to make steel of medium carbon content by the melting of pig iron and low carbon wrought scrap were accompanied by failure due to their inability to obtain a temperature high enough for refining and maintaining fluidity while teeming. It was not until they incorporated the Siemens regenerator chambers with their reverberatory furnace that they were able to obtain temperatures sufficiently high to produce steel in an open hearth furnace. Thus began the Siemens-Martin or open hearth process which was destined to supplant gradually the maiden process for the manufacture of steel in large tonnages. The regenerators, then as now, were known as chambers wherein brick were piled in a checker-like arrangement for the intercepting or conserving of heat from the hearth gases, which on succeeding reversals, were to be used to heat the incoming air and gas to insure increased flame temperature.

That the regenerators were a necessary adjunct was recognized, but notwithstanding this, little thought or consideration was given to their design. It is only within the past decade that designers have realized the relatively low efficiency of open hearth

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furnaces and have directed their efforts toward checker design to obtain maximum heat conservation.

In the early days of open hearth furnace design, vertical checkers were placed directly underneath the hearth, the checker walls serving as supports for the hearth proper. This practice has been abandoned almost entirely due to the weakening of the checker walls arising from alternate expansion and contraction during the periods of heating and cooling. With this attenuated arrangement the checkers were almost inaccessible for making repairs. With the addition of slag pockets, wherein the particles which are carried over mechanically with the outgoing gases are deposited by virtue of change of direction, horizontal checkers are now almost standard practice. The relative size of air and gas chambers, as designed for a furnace using producer gas as fuel, has always been a moot question. In general, it may be said that their proportions are in the same ratio as the calorific capacity of air and gas simultaneously heated. This total capacity ratio is calculated on the basis of moisture-free air and gas for the temperature gradient at which they enter the regenerator and are desired to enter the hearth. This ratio is approximately that each volume of gas requires 1½ volumes of air. The empirical volume of air and gas checker, therefore, is about 1½ to 1. This ratio, however, is not strictly adhered to inasmuch as about 10 per cent more air is used than is necessary for complete combustion and the gas need not be heated to quite as high a temperature.

Dimensions are Inter-Related

Aside from accuracy of relative volumes, the dependence of length, breadth and depth are important factors of design. In determining the length of the regenerator in line of gas travel to the stack, it must be borne in mind that the gases must pass through at a slow velocity rate, thereby being assured of a proper cooling of the outgoing gas before going to the stack and a proper heating of the incoming air and gas before entering the furnace. In other words, the larger the cross-section and the lower the velocity, the shorter the length, and the more reduced the cross-section and the greater the velocity, the greater must be the checker length. A satisfactory checker length depending on cross-section is 15 or 20 feet. The cross-sectional area of the checker, whereby is meant the aggregate area of the free air spaces, should be so designed that the gas velocity be not greater than 10 feet per second. The gas passages must be large rather than small, as a safeguard against retardation of gas flow due to friction. It also must be remembered that the area of these passages is constantly being reduced due to deposition of particles of slag, ore dust and other materials from the outgoing gases resulting in further frictional retardation due to the rough surfaces.

With a knowledge of maximum gas temperature and the quantity and velocity thereof passing through the regenerator, the free passage area may be readily determined. With this information and the amount of space occupied by the checker brick, the cross-section of the checker may be calculated.

Checker Depth

Aside from the length and cross-section of the checkers, the function of depth must not be lost sight of. The chief function of checker depth, aside from augmenting ideal cross-section, is to expedite the flow or travel of the incoming air and gas because of the stack-like draft effect which is directly proportional to depth. If the checkers are made deep instead of shallow, the incoming gases are forced by this natural draft to seek the hot places, and the outgoing gases to find the cool areas; thus, automatically, the regenerator temperature is equalized throughout. In early designs, when the checkers were placed beneath the hearth the draft effect of the deep vertical regenerators was greater than that of the present-day long horizontal type wherein often there is no propelling force, except the port uptakes.

The checker volume, whereby is meant the aggregate volume occupied by filled and free air spaces, usually is referred to in terms of *per ton* of furnace capacity. This volume does not include that portion above the checker brick or the flues underneath. In early design, 50 to 75 cubic feet per ton of rated furnace capacity was considered good practice. Present-day design allows between 85 to 95 cubic feet per ton and in one or two instances, up to 110 cubic feet. It is evident that the larger the checkers the greater will be the amount of heat conserved and the lower the temperature of the gases going to the stack. This, however, might be carried to such an extreme that the temperature of the outgoing gases would be equal to that of the incoming, thereby eliminating the propelling force of the cold gases seeking the hot areas. In addition to this, the maximum temperature would be so much reduced as to be insufficient for efficient flame combustion. The high cost of refractories also would limit the building of abnormally large checkers even if they might be desirable. The chief function of the regenerators is to conserve sufficient heat units of maximum temperature to heat the incoming air and gas to a temperature high enough for efficient flame combustion. The temperature of outgoing gases from a checker so designed will be about 300 to 500 degrees Cent.

Each designer has his own opinions regarding checker brick arrangement. The fundamental fact which must be borne in mind, however, is that the arrangement must be such as to offer a maximum area for absorption and a minimum retardation to gas flow. In addition to this, the facility with which brick may be cleaned at the end of a campaign must be given consideration. In the old time arrangement which is still popular even today, wherein the brick were so laid as to produce both vertical and horizontal flues, it was almost always necessary to remove all brick for cleaning at the end of a campaign, resulting in much breakage and increase repair costs. When the bricks are laid to produce either vertical or horizontal flues, the flue may be cleaned with a boiler flue brush at the end of a campaign, thereby eliminating brick removal.

Silica Brick Checkers

It has long been the practice to use fire brick for checkers. During the past few years the use of silica brick, because of their increased conductivity, has come into favor. The first cost of silica brick is higher, but the gain in efficiency and economy warrants their use. The writer has in mind an installation in which silica checker brick were used, from which 2,500 heats were tapped before it became necessary to replace the brick, except the first two top courses, at the end of a campaign. Some furnace designers have used standard brick shapes, others have designed and patented special shapes and others have designed brick on a basis of thermal conditions.

During the past few years there have appeared in the technical press the results of the investigators, Queneau, Wolodigne and Osann, on the heat conductivity of gas permeability of commercial refractory materials. Unfortunately their investigations were conducted under laboratory conditions and at temperatures considerably lower than actual furnace working conditions. Their results seem to indicate with certainty that the temperature at which brick are burned

influences the heat conductivity, that is, the higher the burning temperature the greater is the conductivity. Even though a correct burning temperature might be attained, it would be difficult to exact such requirements from a brick maker. It also was found that conductivity increases with temperature. The maximum temperature of the checkers, in general, is unknown until the furnace is in actual operation. To design a brick to withstand this temperature might necessitate the specification of a special mixture which might offset the desired burning temperature. With a specific knowledge of the conductivity of the various refractory materials and the amount of heat which must be conserved between reversals, a brick of ideal dimensions, which undoubtedly would be smaller than a commercial brick, might be designed. The efficient conductivity of the ideal brick would be influenced by the reducing action of carbon monoxide on the iron content of the brick mixture and by the carbon deposition due to gas permeability in the heart of the brick. The gas permeability and carbon deposition, in all probability, are the fundamental causes of checker brick deterioration. All of these theoretical considerations would seem to indicate that the ideal checker brick would be smaller in cross-section than those of present practice. The advantages which they might have are offset by decreased life, increased cost of manufacture, and breakage in handling. The decreased life would necessitate more frequent replacement of checker brick and would increase repair cost.

Of equal importance with checker design is the proper dependent design of ports, sewers for incoming gas and air, and flue to the stack. They must all be designed to permit a free and uniform passage of air and gas at the desired velocity throughout the entire area of the checkers.

The Metamorphosis of the Foundry

By R A Bull

THERE are certain tendencies characteristic of this era of efficiency that we, as foundrymen, should consider in sober-minded fashion. Shops where metals are cast are and should be tremendously concerned in the present wide-spread movement for the highest industrial development. It may perhaps be truthfully stated that foundries have even now more knowledge to acquire in the attainment of efficient operation and the intelligent selling of their product than do many other manufacturing businesses. Foundries have made vast progress in the past two decades. We still have much to learn from more highly developed lines of industry. Time was in our own recollection when molding methods were of the crudest; when fractures governed the purchase of pig iron; when mixtures were largely matters of guesswork and superstition and when foremen were selected with much thought as to their imposing height and muscular development.

In adapting ourselves to our now recognized higher plane of thought and deed, and in properly striving for the greatest efficiency, I venture the suggestion that we proceed along sane, conservative lines. Human nature is such a peculiar attribute that it frequently urges us to go from one to the other extreme. There seems to me some risk that we may carry our measures for efficient operation too far, if we do not make careful analyses of causes and effects. Specialization may be overdone and can do great injury to plants and workmen if not skillfully kept in proper bounds. It is essential that we keep in mind the highest development of workmen as well as of machines, and avoid making these terms synonymous. If we do not, we will surely and justly suffer from a dearth of skilled mechanics. I was once informed of a workman whose sole task consisted of pressing the treadle of a machine with his right foot. The operator's task gradually gave him an abnormal development on one side of his body, and this was finally so apparent that it was regarded as a humorous matter, until the tragedy of the situation dawned on those who were responsible. The average workman of today argues that the manufacturer is constantly striving to displace men with mechanism. The progressive plant owner will admit the necessity for utilizing mechanical devices wherever these may profitably supersede manual labor, in order that he may meet competition. The intelligent buyer favors the mechanically produced article, in the belief, in the main correct, that it is more accurately made. But the whole trend of industrial progress creates a greater need today for skilled mechanics in greatly diversified lines than ever before existed, and I think we want to take good care of our artisans and help to make them better ones. Further, we should, aggressively but tactfully do all that we can toward creating in our schools, a source of supply of intelligent craftsmen. We do not want to get rid of the skilled mechanic, but rather do we need to apply his trained hands and mind to work that they can best do, and to gradually develop him in all ways that may enable him to better himself and ourselves. Specialization is necessary, but it has its own limitations, if we give proper heed to our future need for skilled workmen as our processes develop, and if we do not have solely in mind the immediate present.

In properly selecting employes with regard to especial fitness, and in maintaining such shop regulations as we believe will conduce to their mental, physical and moral well-being, I venture to advise a more conservative attitude than sometimes exists. The most efficient organization cannot in my opinion be in that plant where the men are expected to be nervously "on their toes" for every minute of time while they are on duty, and where

Presidential Address

The annual business session of the American Foundrymen's Association, which took place at the Hotel Traymore, Atlantic City, N. J., on Wednesday evening, Sept. 29, in connection with the convention of the allied foundry organizations, was noteworthy on account of the splendid address of the retiring president, R. A. Bull, manager of production, Commonwealth Steel Co., Granite City, Ill.

The address contained an illuminating account of the activities of the American Foundrymen's Association during the past year, which clearly indicates the scope and value of the work carried on by this great organization. Mr. Bull, however, by no means confined himself to the immediate affairs of the organization of which he is the head, but presented, in addition, a masterly analysis of several of the most important problems now facing the foundry business. In this respect, therefore, his address is of universal interest, and inasmuch as our space does not permit of its publication in full, we are presenting only those portions that deal with the casting industry as a whole.

there is not reasonable tolerance in little things. Man is so constituted that he needs throughout each day, whether he figuratively pulls the plant whistle or literally wields a shovel, occasional moments of partial relaxation. And we act unwisely, and indeed inefficiently in the final analysis, if we do not take into full account the human element in man, imperfect as it may be in many respects, but ever present, as it certainly is.

This thought with respect to workmen impels me to hazard an expression concerning foremen. It has lately seemed to me that many of us have maintained a rather unjust and thoughtless attitude toward our foundry foremen and their assistants on the molding floor and in the coreroom. Do we often stop to think of one of these except from the standpoint of the amount and quality of work he can get out of his men? Do we pause to consider the thanklessness of the foundry foreman's job, day in and day out? Have we often given him opportunity for hope that he may aspire to better things in this age when technical men are much in demand for higher executive positions in our business? Under ordinary circumstances when we need an assistant foundry foreman, we select a dependable skilled molder. Formerly when a superintendent was wanted, a head molding foreman of proved mechanical and executive ability was often promoted.

Should Consider Service

In later years not a few of the many ambitious technical graduates from our colleges happily have looked to the foundries as likely places for advancement, and a suitable field for the application of their theoretical knowledge. We find good use for many such, but frequently along special lines that do not provide the closest knowledge of operations distinctly peculiar to melting, molding and core-making. When we require an assistant for general plant supervision, we are much more apt to select the young engineer than the foundry foreman, who is frequently left to the sand heap and his own salvation until he gets too old for the job, and wearies of his undeniably annoying responsibilities.

Judging by modern methods of selection in promotion, the foreman should be given opportunities that he does not, according to my observation, at present enjoy in some foundries. And looking at the situation from the viewpoint of efficient production, I admit to being one of those who yet strongly believe that actual experience in getting one's own hands into things, and the ability to personally and satisfactorily perform operations that are given one to oversee are very important elements of preparation for executive work, not always essential, but invariably desirable. I know from my limited experience that wonders can be done along educational lines with foremen of middle age who had the advantage of only a half-dozen years at school. A most creditable knowledge of mechanical drawing can be acquired by such men, when it is tactfully presented, and the value of these foremen to the plant organization is thereby greatly increased with slight direct expense, which may well be disregarded in consideration of the lasting benefits secured.

The Consulting Specialist

I have referred to efficiency as applied to workman and foreman. A few comments concerning the consulting foundry specialist are apropos. That this individual has a legitimate function to perform in modern founding is granted by all who consider the matter impartially. There are persons whom nature has not supplied with that amplitude of patience needed for the performance or supervision of routine affairs, but whose ready perception, ability to develop possibilities in previously untried methods, and temperament for analytical study of mechanical and scientific problems admirably fit them for experts to be engaged for working out special processes, or bringing to light obscure causes for trouble. It is well that such persons are available and it is not to their discredit that they may be jokingly referred to as "efficiency doctors." Their greatest handicap seems to me to lie in themselves, and to be due to personnel.

Expressing the proposition plainly, there is among these self-advertised exponents of efficiency, a regrettable number of pseudo-experts who have failed to make good at specific tasks in the foundry business, and who have entered the consulting field as promising better returns to those who have the faculty of talking well and magnifying the importance of their personal knowledge to credible foundrymen in difficulties. One of these individuals after a half-hour's hurried walk through a large foundry that he never saw before, comfortably seated himself in the manager's office and delivered himself of the definite statement that the foundry was being operated at 70 per cent of its efficiency. Another rash gentleman publicly advertises: "Y-ou get immediate results and begin at once to make savings on fuel, material, etc., bettering the product 24 hours after consulting me. You make no experiments. Every foundry needs our facts, figures, and efficiency methods." And still another, throwing self-effacement to the four winds is responsible for this astonishing printed notice: "If you are having foundry troubles consult me, the man who knows foundries from A to Z. No matter what the question is, if it pertains to the foundry, I can solve it and save you money. There is absolutely nothing in connection with foundry work of which I am not thoroughly master."

It is to be regretted that there is not universally among consulting men in this field that ethical point of view which exists among consulting experts in many other lines of endeavor and which serves to discredit exaggerated claims, difficult or impossible to substantiate. We as foundrymen can advance our own interests and can be of service to those foundry experts who are of real help to us, and whom consequently we are glad to occasionally engage, by strongly discouraging absurd claims, and by warning the unwary foundryman in trouble to beware of the personage who has learned it all.

The March of Progress

During the present generation there have been such revolutions in the cost of production of cast metals of all kinds, that a brief story of this progress has all the interest of magic for its readers. Within the recollection of some of my hearers aluminum, which before the present war was quoted at 22c, sold for $90 per pound, and steel castings which now sell frequently at 3c per pound were never purchased 60 years ago for less than 12½c per pound.

Metallurgical processes have indeed wrought wonders in making available for man's daily use, those ferrous and non-ferrous alloys which take definite form in molding sand. The development of the foundry is a most important feature of the social and industrial advancement of the human race. On the American continent, as in Europe, tyranny has been overthrown in the past mainly by the use of castings in various forms. The venerated bell which has its permanent shrine in Philadelphia, and which rang out in 1776 the declaration that the American people would henceforth exist only as an independent nation, was born in a humble foundry and was literally cast three times before its makers were satisfied with its qualities. Paul Revere in his own day achieved more fame in casting and forming precious metals than in making his historic midnight

CHORDS OF ANGLES FROM ONE TO NINETY DEGREES

By S. L. Cook.

Many cases will occur in building and laying-out patterns, where a square protractor or bevel cannot be used, and in such cases this table will be of service. It will be observed that the 10-inch radius can be easily taken on a 12-inch scale, the 22-inch radius on a 24-inch scale, and the 48-inch radius by laying down two lengths of the 24-inch scale.

To lay-out the required angle, scribe an arc, using one of the given radii, then set the trammels to the length of the chord given in the table for the required angle, layout on the circle and connect these points with the center.

Angle in degrees.	10-inch radius.	22-inch radius.	48-inch radius.	Angle in degrees.	10-inch radius.	22-inch radius.	48-inch radius.
1	1/64	3/8	1/8	16	2 3/64	6 7/64	13 1/32
2	1/32	1/64	1 1/16	17	2 3/32	6 33/64	14 1/32
3	3/64	1 3/64	2 1/2	18	3 3/64	6 61/64	15 3/64
4	1/16	1 3/32	3 3/64	19	3 1/16	7 1/32	15 31/32
5	7/8	1 31/64	4 1/32	20	3 1/16	7 5/8	16 31/32
6	1 3/64	2 5/16	5 3/64	21	3 1/32	8 3/64	17 15/16
7	1 3/32	2 1/16	5 31/64	22	3 13/32	8 15/32	18 31/32
8	1 15/64	3 1/16	6 1/32	23	4	8 31/32	19 3/64
9	1 31/64	3 13/32	7 1/32	24	4 3/64	9 3/32	19 31/32
10	1 1/4	3 31/64	8 1/64	25	4 1/64	9 1/2	20 15/16
11	1 15/64	4 1/64	9 3/32	26	4 1/2	9 15/32	21 31/32
12	2 3/32	4 1/32	10 1/32	27	4 1/64	10 3/32	22 15/16
13	2 1/64	4 31/64	10 31/32	28	4 3/64	10 1/64	23 15/16
14	2 1/16	5 1/16	11 15/16	29	5 3/64	11 3/64	24 3/64
15	2 15/64	5 31/64	12 31/32	30	5 1/16	11 15/64	24 31/64

(*Continued on Data Sheet No.* 196.)

CHORDS OF ANGLES FROM ONE TO NINETY DEGREES

By S. L. Cook.

(*Continued from Data Sheet No.* 195.)

Angle in degrees.	10-inch radius.	22-inch radius.	48-inch radius.	Angle in degrees.	10-inch radius.	22-inch radius.	48-inch radius.
31	5 1/32	11 7/64	25 1/64	61	10 5/32	22 31/64	48 1/64
32	5 3/64	12 1/8	26 1/16	62	10 1/16	22 33/64	49 1/16
33	5 1/16	12 1/2	27 3/32	63	10 9/64	22 63/64	50 3/32
34	5 3/32	12 7/8	28 5/64	64	10 1/32	23 31/64	50 7/8
35	6 1/64	13 3/32	28 31/32	65	10 1/4	23 33/64	51 31/32
36	6 1/16	13 31/32	29 31/32	66	10 7/32	23 31/64	52 31/32
37	6 3/32	13 31/32	30 31/32	67	11 5/64	24 3/32	53
38	6 3/32	14 31/32	31 15/32	68	11 1/16	24 1/32	53 31/32
39	6 1/16	14 1/16	31 31/32	69	11 3/32	24 3/32	54 31/32
40	6 3/32	15 5/64	32 31/32	70	11 31/64	25 1/32	55 5/64
41	7	15 1/32	33 31/32	71	11 31/32	25 31/64	55 31/32
42	7 1/64	15 31/32	34 31/32	72	11 31/32	25 7/8	56 1/16
43	7 1/32	16 1/8	35 1/16	73	11 31/32	26 1/16	57 1/8
44	7 1/32	16 31/64	35 31/32	74	12 5/64	26 31/64	57 31/32
45	7 1/32	16 31/32	36 31/32	75	12 1/32	26 31/32	58 31/32
46	7 3/32	17 1/16	37 31/32	76	12 1/16	27 5/64	59 5/64
47	7 31/64	17 1/32	38 1/4	77	12 31/64	27 31/64	59 31/32
48	8 1/16	17 7/8	39 5/64	78	12 1/32	27 1/16	60 1/16
49	8 1/32	18 1/32	39 31/32	79	12 33/64	27 31/32	61 5/64
50	8 3/32	18 3/32	40 1/16	80	12 35/64	28 1/32	61 31/32
51	8 3/32	18 1/16	41 31/32	81	13	28 31/64	62 1/16
52	8 1/32	19 1/32	42 1/16	82	13 1/16	28 31/32	62 31/32
53	8 3/32	19 5/64	42 1/8	83	13 1/4	29 1/32	63 31/32
54	9 5/64	19 31/32	43 31/32	84	13 3/16	29 1/16	64 1/32
55	9 1/32	20 1/32	44 1/32	85	13 31/64	29 33/64	64 31/32
56	9 1/32	20 1/32	45 5/64	86	13 31/32	30	65 1/16
57	9 1/32	20 31/32	45 31/32	87	13 1/32	30 1/32	66 1/32
58	9 1/32	21 1/32	46 1/16	88	13 31/64	30 1/16	66 31/32
59	9 1/32	21 1/32	47 1/32	89	14 5/64	30 33/64	67 31/32
60	10	22	48	90	14 5/64	31 7/64	67 7/8

THE FOUNDRY DATA SHEET, OCTOBER, 1915

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

ride. The beauty of art, the sentiment of commemorative objects, the utility of present day necessities of domestic and industrial life are in enormous degree the products of the industry of which we are servants.

The sand pile has indeed fulfilled a useful and honorable mission. How can we doubt that in future years, the art of casting metals will make much greater strides than in the past? Foundry scientists were never before so numerous and so practical as today. We are rapidly acquiring a very comprehensive knowledge of the peculiarities of the elements and their behavior when placed in combination with one another. Certain characteristics which they possess are today little understood, but the problems that remain unsolved are being vigorously attacked. One question which now puzzles the brains of founders and others is that which may determine the cause and remedy for what is sometimes termed "strain-disease", or the decay of metals apart from corrosive action. Another conundrum is found in the need for molds of permanent nature, in seeking which large sums have been expended, and profitably so in certain restricted fields. Who can say that in the future we may not find means of largely eliminating the shrinkage which occurs when molten metals solidify, and thus at once remove the barrier which is imposed against the adoption of molds of inflexible and indestructable nature, and coincidentally cause to vanish that *bete noir* of foundrymen, the shrinkage crack?

For results already achieved, and those we look for, we as foundrymen do not and will not claim all the credit. The parts played by the mechanical and electrical engineers in the wonderful development of processes in the foundry have been of immeasurable importance, and will continue so. In no small degree are we indebted to the makers of alloys and to those purely scientific investigators who are not commercially identified with the casting of metals. The larger foundries happily have today in their service a great number of technical experts and metallurgists of ability. Such men working in conjunction with those having practical knowledge of foundry conditions are developing research work along constructive lines which promises much for the future. It is not a matter for surprise that the intensely interesting and to some extent mysterious transformations that daily occur within the prosaic walls of the foundry have drawn to us such intelligent and inquiring minds, that gradually our occupation as foundrymen has been elevated from a mere calling, as it was regarded yesterday, to an honored profession, as it is acknowledged today. I believe I am voicing the thought that is now in your minds when I say that the main factor in all this advancement, this search for knowledge, this growth in personnel, this exchange of ideas, which combined have brought about the present gratifying conditions, and which promise so much for tomorrow, has been organization among foundrymen.

Dynamic Qualities of Cast Steel

By J Lloyd Uhler

THE recognized importance of knowing something more than the static properties of steel employed in the manufacture of castings for various uses, such as locomotives, turbines, electric cranes, etc., has in recent years led some steel foundrymen to make a thorough study of

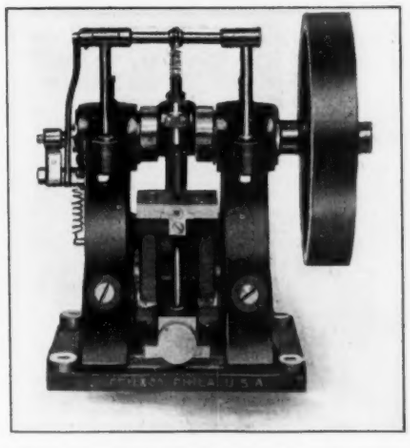


FIG. 1—TURNER & LANDGRAFF TESTING MACHINE

their product. It is just as essential to know the probable behavior of steel in service which is subjected to shock or alternating stresses, as it is to know its static properties. Too much reliance generally is placed upon the limited information furnished by the static tension test, with the result that numerous failures in practice often seem inexplicable, and for that reason experiments were begun, to find some other device which, in a commercial manner, would divulge something concerning the other properties of the castings.

It has been long understood that materials are liable to degenerate in quality at a rate depending upon the service which they undergo. The numerous every-day failures which cannot be accounted for, are forcing the metallurgical investigators to make research and investigations into the action on steel exerted by complicated forces and they realize the fact that resistance to fatigue is not entirely a function of static strength.

Original Vibrating Machine Used

In 1907 the manufacture of vanadium steel castings was started on a small scale and one of the claims for this alloy was resistance to fatigue. This claim was investigated to determine whether it could be substantiated, and in July, 1907, test bars of carbon and vanadium steels were prepared, which were tested, by courtesy of the Pennsylvania Railroad Co., at Altoona, Pa., on an improvised vibratory machine which was used for making tests of staybolt iron. This machine was an old slotter that had been equipped for making vibratory tests and was provided with a registering device which gave a complete record of the number of alternating stresses. The bar was fastened rigidly in a vise and extended out to the slotter arm, 8 inches distant. It had a plate fastened to the arm with a hole through it so that the free end of the test bar, which was supplied with a round nut, could be placed in it with an allowance

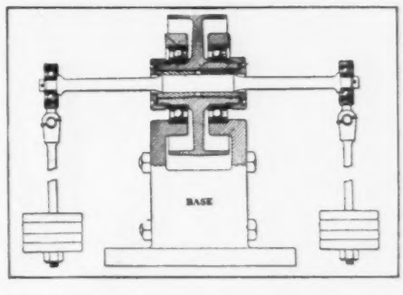


FIG. 2—CROSS-SECTION OF WOHLER TESTING MACHINE, ALSO KNOWN AS THE SOUTHER TYPE

of ¼-inch play, thereby allowing the test bar to be deflected ⅛-inch each side of the neutral position. This machine gave only 30 vibrations per minute. The size of the bar was ⅝-inch round and 15 inches long.

The Turner & Landgraff testing machine was next employed by investigators. This is the new modification of Wohler's method of dynamic testing,

A paper read at the annual convention of the American Foundrymen's Association, Atlantic City, N. J., Sept. 28 to Oct. 1.

Dynamic and Static Results Obtained on

Castings made from steel containing.....0.20 to 0.25, 0.25 to 0.30, 0.33 to 0.40 and 0.40 to 0.50 per cent carbon
Castings made from vanadium steel containing.....0.23 to 0.28, 0.38, 0.47 and 0.49 per cent carbon
Castings made from chrome nickel steel containing.....0.31 to 0.38 per cent carbon

Heat No.	Elastic limit, per square inch.	Ultimate strength, per square inch.	Elongation, per cent, in 2 inches.	Red. of area.	Vibration.	Average vibration.	Chemical analysis, per cent. Carbon.	Phosphorus.	Manganese.	Sulphur.	Silicon.	Vanadium.	Nickel.	Chrome.
7540	34,900	67,400	27.5	42.46	2,354		0.205	0.043	0.700	0.032	0.270	.....	.....	.....
7054	34,880	63,400	39.0	55.02	2,453	2,437	0.205	0.043	0.700	0.032	0.270	.....	.....	.....
					2,248									
					2,693									
333D	32,040	70,400	28.5	43.8	3,520		0.240	0.045	0.570	0.038	0.249	.....	.....	.....
333D	32,200	69,900	31.0	51.0	2,280	3,102	0.240	0.045	0.570	0.038	0.249	.....	.....	.....
333D	31,130	70,040	30.0	47.9	3,510		0.240	0.045	0.570	0.038	0.249	.....	.....	.....
8875	37,160	71,700	33.0	48.2	2,010	3,449	0.250	0.036	0.600	0.024	0.230	.....	.....	.....
8875	36,710	70,180	31.5	52.8	1,826		0.250	0.036	0.600	0.024	0.230	.....	.....	.....
229D	37,240	69,460	29.5	49.6	3,128	1,918	0.250	0.032	0.610	0.028	0.259	.....	.....	.....
229D	39,600	69,680	29.5	50.1	3,770		0.250	0.032	0.610	0.028	0.259	.....	.....	.....
227D	36,950	71,650	29.0	45.2	3,972	3,228	0.270	0.031	0.580	0.028	0.277	.....	.....	.....
227D	36,740	71,460	29.0	46.8	2,483		0.270	0.031	0.580	0.028	0.277	.....	.....	.....
470C	38,510	76,700	29.0	44.1	3,512	3,104	0.270	0.047	0.630	0.027	0.280	.....	.....	.....
470C	38,050	76,100	29.0	46.9	2,940		0.270	0.047	0.630	0.027	0.280	.....	.....	.....
470C	37,240	76,500	28.5	47.4	2,860		0.270	0.047	0.630	0.027	0.280	.....	.....	.....
473C	38,560	79,660	25.0	45.5	3,255	3,522	0.280	0.044	0.630	0.026	0.329	.....	.....	.....
473C	38,050	80,680	24.0	42.5	3,522		0.280	0.044	0.630	0.026	0.329	.....	.....	.....
473C	38,210	78,960	27.5	45.2	3,378		0.280	0.044	0.630	0.026	0.329	.....	.....	.....
624C	34,750	73,400	25.0	41.3	3,803	3,867	0.330	0.034	0.610	0.030	0.290	.....	.....	.....
624C	35,800	78,380	22.0	44.3	3,930		0.330	0.034	0.610	0.030	0.290	.....	.....	.....
461C	44,790	91,100	21.0	27.5	3,029		0.370	0.043	0.700	0.025	0.305	.....	.....	.....
461C	45,480	91,970	21.5	36.5	3,066		0.370	0.043	0.700	0.025	0.305	.....	.....	.....
461C	43,930	89,870	22.0	39.4	3,679	3,258	0.370	0.043	0.700	0.025	0.305	.....	.....	.....
481C	43,280	88,580	24.5	37.7	3,009		0.375	0.044	0.740	0.029	0.291	.....	.....	.....
481C	.....	.....	....	....	2,945	3,115	0.375	0.044	0.740	0.029	0.291	.....	.....	.....
481C	.....	.....	....	....	3,393		0.375	0.044	0.740	0.029	0.291	.....	.....	.....
447D	40,600	84,720	25.0	40.1	2,958		0.386	0.046	0.680	0.035	0.300	.....	.....	.....
447D	40,100	82,710	23.0	33.8	3,350	3,154	0.386	0.046	0.680	0.035	0.300	.....	.....	.....
9034	57,460	96,740	19.0	30.7	1,999		0.400	0.049	0.730	0.029	0.310	.....	.....	.....
9034	60,100	97,340	17.5	23.0	.....	1,999	0.400	0.049	0.730	0.029	0.310	.....	.....	.....
9215	45,660	76,620	27.5	51.1	3,000		0.235	0.047	0.575	0.030	0.250	0.145	.....	.....
9215	42,590	78,200	31.0	51.8	2,904	3,265	0.235	0.047	0.575	0.030	0.250	0.145	.....	.....
464C	48,550	82,620	26.0	47.7	2,978		0.235	0.028	0.590	0.025	0.280	0.180	.....	.....
464C	48,530	79,900	25.5	49.8	2,722	3,057	0.235	0.028	0.590	0.025	0.280	0.180	.....	.....
464C	46,740	73,900	29.5	52.2	3,471		0.235	0.028	0.590	0.025	0.280	0.180	.....	.....
479C	47,330	75,000	29.5	53.8	3,360									
479C	46,440	72,120	29.5	52.8	3,054	3,273	0.245	0.038	0.610	0.029	0.310	0.190	.....	.....
479C	47,420	79,460	25.5	49.1	3,406		0.245	0.038	0.610	0.029	0.310	0.190	.....	.....
77E	48,400	77,500	27.5	45.6	3,096	2,952	0.250	0.042	0.572	0.023	0.250	0.194	.....	.....
77E	49,380	80,120	27.5	48.0	3,434		0.250	0.042	0.572	0.023	0.250	0.194	.....	.....
306D	47,500	75,040	27.5	50.0	4,218		0.250	0.038	0.550	0.030	0.254	0.200	.....	.....
306D	46,810	74,980	29.0	53.2	4,102	4,074	0.250	0.038	0.550	0.030	0.254	0.200	.....	.....
306D	.....	.....	....	....	3,902		0.250	0.038	0.550	0.030	0.254	0.200	.....	.....
433E	47,750	82,870	23.5	44.2	4,510		0.255	0.041	0.580	0.035	0.268	0.178	.....	.....
433E	48,010	80,860	23.5	44.2	4,356	4,192	0.255	0.041	0.580	0.035	0.268	0.178	.....	.....
433E	48,310	83,540	22.0	42.9	3,710		0.255	0.041	0.580	0.035	0.268	0.178	.....	.....
372D	47,500	80,000	24.0	39.0	2,966	2,966	0.260	0.035	0.510	0.028	0.260	0.203	.....	.....
67E	49,060	82,080	26.0	44.5	3,190	3,335	0.260	0.039	0.624	0.025	0.290	0.205	.....	.....
67E	47,420	78,480	28.0	48.0	3,480		0.260	0.039	0.624	0.025	0.290	0.205	.....	.....
74E	48,720	79,320	26.0	47.7	3,476	3,476	0.260	0.043	0.576	0.022	0.260	0.190	.....	.....
74E	49,380	80,640	25.0	50.1	.....		0.260	0.043	0.576	0.022	0.260	0.190	.....	.....
35E	41,760	79,640	28.0	44.2	4,320	3,965	0.265	0.034	0.638	0.023	0.270	0.203	.....	.....
35E	41,190	82,380	26.0	43.6	3,610		0.265	0.034	0.638	0.023	0.270	0.203	.....	.....
226D	48,120	86,220	23.5	40.1	3,834	3,781	0.280	0.026	0.660	0.028	0.306	0.165	.....	.....
226D	48,620	88,720	21.0	38.6	3,728		0.280	0.026	0.660	0.028	0.306	0.165	.....	.....
437E	64,180	111,670	15.0	28.6	2,776	2,567	0.380	0.038	0.700	0.034	0.335	0.188	.....	.....
437E	61,750	113,430	14.5	24.9	2,358		0.380	0.038	0.700	0.034	0.335	0.188	.....	.....
Double annealed, "Berry"														
414D	75,440	133,840	13.5	20.5	3,053		0.470	0.042	0.730	0.032	0.361	0.185	.....	.....
414D	74,440	140,600	10.0	15.6	3,226	3,351	0.470	0.042	0.730	0.032	0.361	0.185	.....	.....
414D	73,980	133,600	15.0	21.8	3,773		0.470	0.042	0.730	0.032	0.361	0.185	.....	.....
Single anneal, "Dividers"														
9155	83,980	119,010	10.5	15.8	3,000	2,952	0.490	0.036	0.710	0.037	0.310	0.175	.....	.....
9155	86,220	123,090	10.0	15.6	2,904		0.490	0.036	0.710	0.037	0.310	0.175	.....	.....
79-D	61,660	105,750	19.0	48.4	3,810		0.315	0.039	0.540	0.026	0.306	.....	1.680	0.810
79-D	62,400	105,800	17.0	31.9	3,790		0.315	0.039	0.540	0.026	0.306	.....	1.680	0.810
79-D	64,420	106,700	17.0	35.2	3,790	3,831	0.315	0.039	0.540	0.026	0.306	.....	1.680	0.810
79-D	63,930	105,270	18.0	36.2	3,478		0.315	0.039	0.540	0.026	0.306	.....	1.680	0.810
79-D	65,920	103,670	19.0	39.9	4,287		0.315	0.039	0.540	0.026	0.306	.....	1.680	0.810
505C	69,500	115,670	16.5	34.0	3,514		0.372	0.038	0.650	0.015	0.277	.....	1.930	1.050
505C	70,420	114,350	15.5	29.0	3,889		0.372	0.038	0.650	0.015	0.277	.....	1.930	1.050
505C	73,360	113,090	18.0	39.2	3,562	3,818	0.372	0.038	0.650	0.015	0.277	.....	1.930	1.050
505C	65,420	113,500	16.5	35.2	4,354		0.372	0.038	0.650	0.015	0.277	.....	1.930	1.050
505C	70,740	111,400	13.5	29.3	3,772		0.372	0.038	0.650	0.015	0.277	.....	1.930	1.050

These tests were made on a Turner & Landgraff machine with a throw of $\frac{1}{16}$-inch and a speed of 760.

which was introduced in 1905 by Prof. Arnold, of Sheffield, Eng. In making this test the piece is held securely in a vise at one end and is moved backwards and forwards by a slotted arm which communicates to the piece successive permanent distortions in each direction, produced by impact and followed immediately by a pushing motion. As a result, the test piece is fractured finally on the line of the vise at which point the most severe stresses are created. The slotted arm moves on a crank, so that the pushing motion is performed without the interfering factor of *rub* as the slotted arm describes the same arc as the distorted test piece. The design of the machine is shown in Fig. 1.

Wohler Endurance Testing Machine

The next series of tests were made on the Wohler dynamic or endurance testing machine. It subjects a specimen to a reversal of bending stresses on a rapidly rotating bar, but this form of testing often gives widely varying results, even from the same bar and does not necessarily detect dynamically weak steel. This is known in this country as the Souther test. Prof. Arnold's original idea in devising this test was to introduce the Wohler method to practical use by reducing the time needed to make this test, namely from days and hours, to minutes. His argument was, that instead of making the test within the elastic limit, but which always was made just beyond it, the result would quickly reflect the liability to fracture within the elastic limit, under stresses applied for a long period. But it was found that the test predicted liability to fracture from causes altogether aside from the Wohler fatigue phenomenon and registered potential brittleness, which the Wohler test not only failed to detect, but pronounced absent. This series of tests was made on the machine shown in Fig. 2.

The investigators then made a series of tests employing the vibratory machine illustrated in Fig. 3. It is built especially strong and the bed, or frame, is so heavy that a specimen of steel, 1¼ inches in diameter and having an elastic limit of 125,000 pounds per square inch, can be tested without causing the frame of the machine to vibrate. This machine was described in detail in the 1914 *Year Book* of the American Society for Testing Materials.

The experiments were made on a Turner & Landgraff machine and the results are given in the accompanying table. The test pieces were 8 inches long, and by reversal, two tests could be obtained from one sample, thereby securing an indication of the uniformity of the metal represented by the test piece. Also the thoroughness of the annealing was thus ascertained, as steel, according to its composition, or rather according to the manner in which the component elements are inter-united, is liable to deteriorate rapidly, or crystallize under the fatigue of continued reversals of stress. The data were gathered with the view of determining the results of impact or fatigue upon steel of different carbon compositions which had been annealed thoroughly in commercial foundry practice. The tabulated record shows that the static results are practically what could be expected from the different chemical compositions, yet the dynamic results prove that even though the chemical analyses are approximately the same in several cases, nevertheless the number of impact stresses are different, due as far as experiments have indicated, to the mechanical energy dissipated during a cycle of stress. It would seem that the lost energy must be transformed into heat, that there must be some form of internal friction in the material that causes wear and structural damage to occur, and that if the action is continued long enough the material will be ruptured. It seems reasonable to consider the amount of structural damage during a cycle of stress to be proportional to the energy transformed into heat, or in other words, to the area of the hysteresis loop. The shape of this loop remains similar to the shape which has been developed under early impact of stress. I believe that a formula which assumes that the same destructive action which occurs under high stress will continue to act with diminished intensity under low stresses, has some indirect evidence in its favor and is a safer guide for designers than a fixed endurance limit below which destruction action is assumed to cease. I endeavored to chart curves from the accompanying tabulated results, using the carbon contents, elastic limits and ultimate tensile strength as the basis, but found that the results, when plotted, were inconsistent, making it impossible to plot a curve from data obtained from material of such a narrow range.

From my personal experience and observation, I do not believe that sufficient importance is assigned to dynamic strains in steel. The object in testing steel is to secure a product which will give longer life in the service in which it is used. Practically the only tests made are static, and while they definitely determine the efficiency of the steel in resisting severe strains, experience has shown that the strength of the steel does not definitely determine its ability to resist fatigue; and I am convinced that more failures result from the innumerable minor vibratory strains than from those which are more severe.

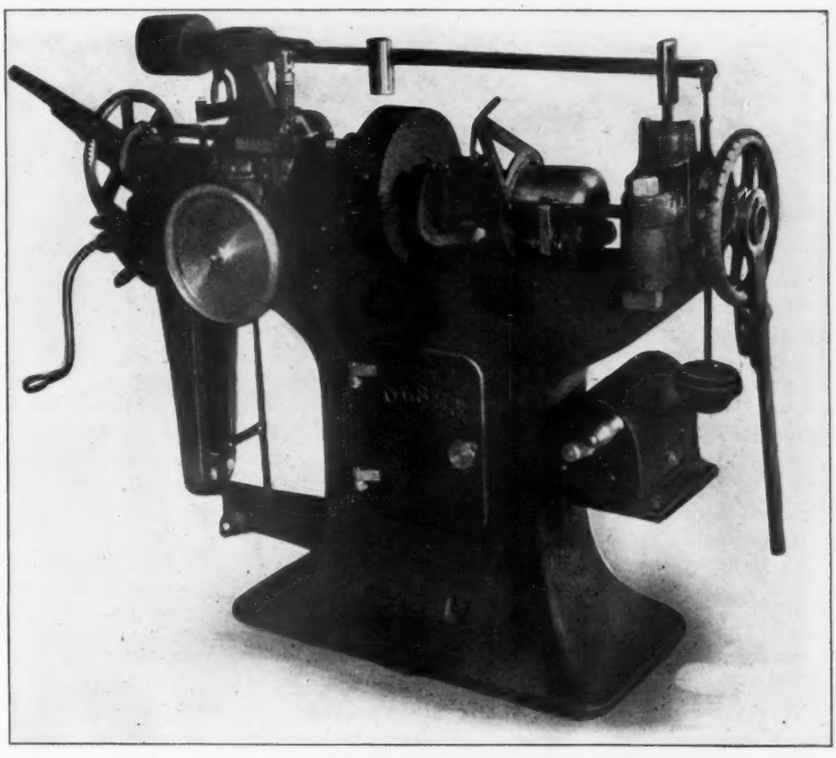


FIG. 3—VIBRATORY TESTING MACHINE DESIGNED BY THE AMERICAN LOCOMOTIVE CO.

The offices, store room and warehouse of the H. W. Johns-Manville Co. have been removed to the company's new building at Michigan avenue and Eighteenth street, Chicago.

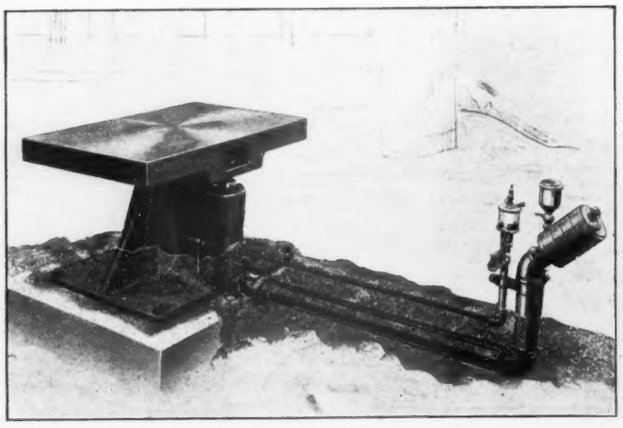


Fig. 1—Plain jar-ramming machine with only sufficient foundation to hold the machine in place

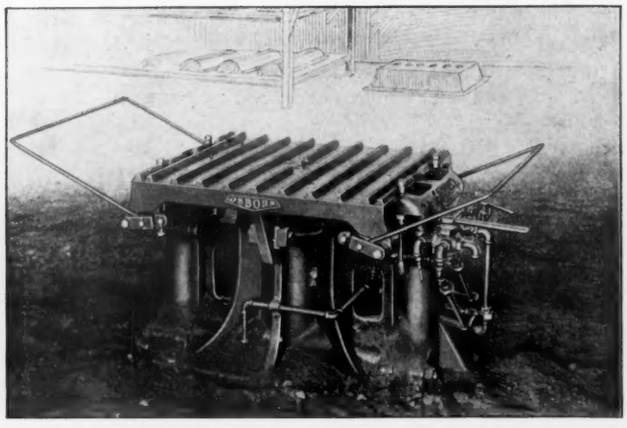


Fig. 2—Foundry floor view of jar-ramming power stripping machine with working parts protected

Foundations for Jar-Ramming Molding Machines

By E S Carman

IN ORDER to intelligently consider the proper foundations for modern jar-ramming machines, it is necessary to review briefly some of the machines of earlier types. In many instances it was considered necessary, to effectively jar-ram a mold, to have a machine that would produce a heavy blow. This usually was accomplished by building the machine with a stroke of 3 to 4 or even 6 inches in length. This stroke, of course, would give the heavy blow, as its action was not unlike the blow which is delivered by a steam hammer. In order to control the ground vibrations produced by such a machine, it was necessary to provide massive foundations, and in many instances the concrete was capped with several layers of wood to aid in the absorption of the blow.

The recent rapid development of jar-ramming machines has practically reversed the early theory of design, as it has been determined that it is not the force of the machine blow that packs the sand, but that it is packed by the jarring table being suddenly or abruptly brought to rest while the sand in the flask to be packed continues its downward course, thereby producing the pressure which results in the sand packing against the pattern or pattern plate. It is quite evident, therefore, that if the machine which has been brought suddenly to rest be instantly started again on its upward stroke and not allowed to pause, that an increased pressure of the pattern against the sand will result, which causes the sand to lay and not rebound.

A jarring machine necessary to accomplish the foregoing need not be unduly massive in its working parts, nor need it have a long stroke, 1 to 2 inches usually being sufficient. It should have means of controlling the force of the blow of the table when contacting with the anvil base, as it is evident that the weight of the moving table, or dead load, must not be allowed to freely drop and contact

Presented at the Atlantic City meeting of the American Foundrymen's Association.

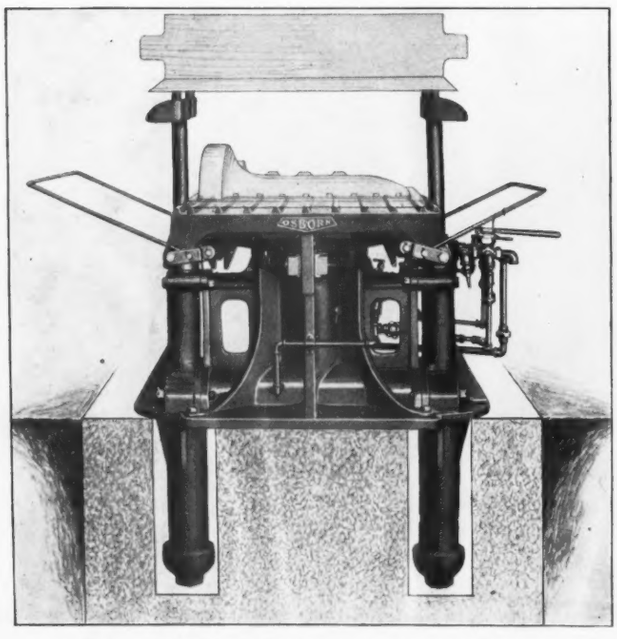


FIG. 3—SAME MACHINE AS FIG. 2, SHOWING SIMPLICITY OF FOUNDATION

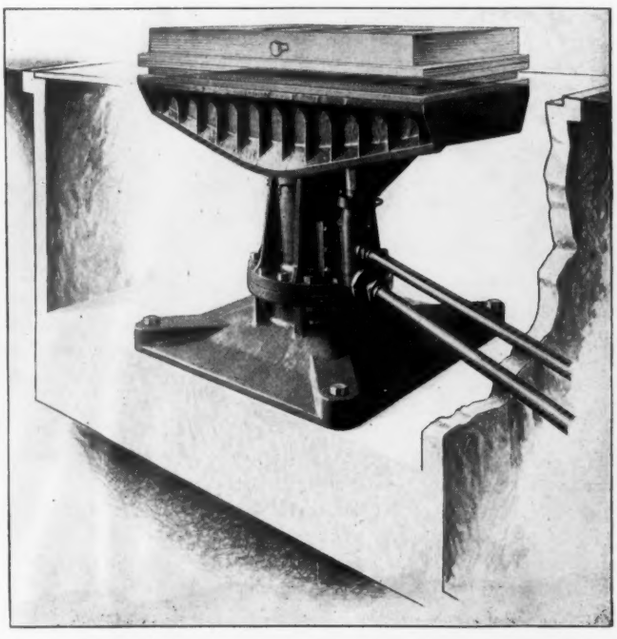


FIG. 4—A LARGE, 42 x 97-INCH, JAR-RAMMING MACHINE, SHOWING THE BASE AND FOUNDATION

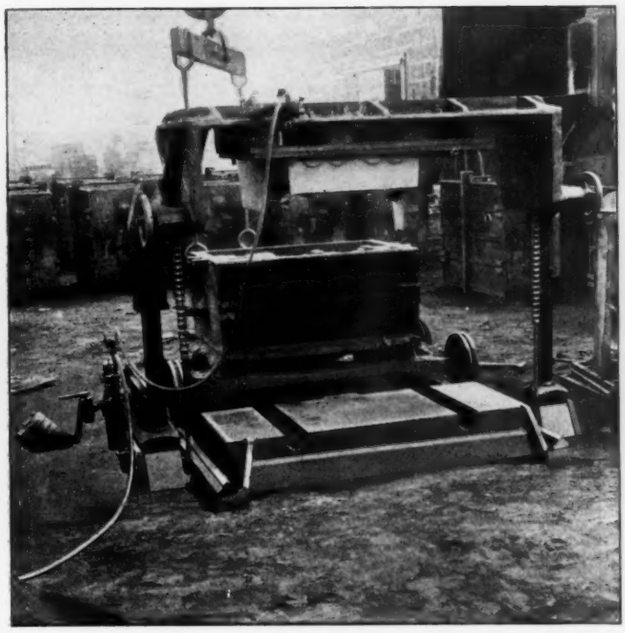


FIG. 5—FOUNDRY FLOOR VIEW OF 54-INCH DIRECT-DRAW ROLL-OVER JOLT MACHINE

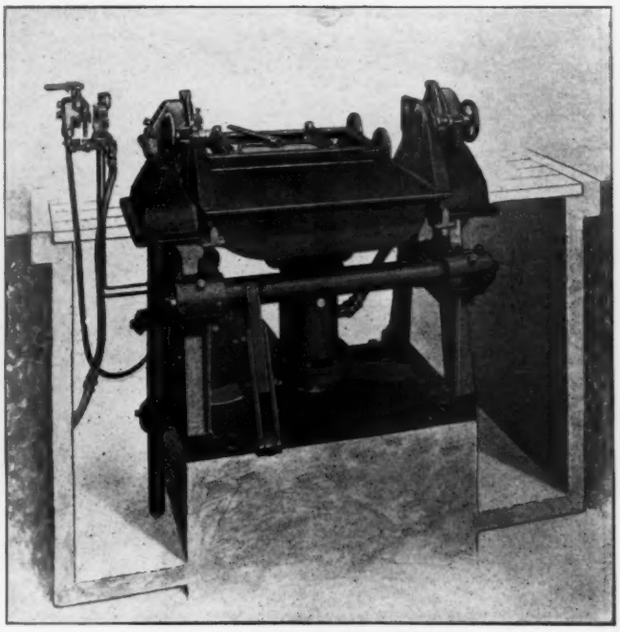


FIG. 6—SAME MACHINE AS FIG. 5, SHOWING SECTION THROUGH FOUNDATION

with the anvil block, or it will produce the unnecessary heavy blow. The up-to-date, modern jarring machine prevents this heavy blow by providing an air cushion under the cylinder sufficient to overcome the violent blow caused by the dead load, allowing only sufficient blow to cause the instant reversal of stroke.

A machine that accomplishes the foregoing not only will ram a good mold in a very short time, but will do so without excessive or detrimental vibration in either the machine, pattern or foundation.

As we now approach our subject—*the machine foundation*—it is evident that with such a machine the extremely massive foundation is not essential and, therefore, our consideration will be from the standpoint of economy and accessibility.

Kind and Nature of the Soil

Of first importance is the kind and nature of the soil upon which the machine foundation is to be placed. A dry gravel is considered the next best thing to solid rock and will safely stand a load of 6,000 to 8,000 pounds per square foot. Dry sand or dry sand and gravel mixed makes a very good foundation base and will withstand a load of 4,000 to 8,000 pounds per square foot. Clay soils vary widely; a soft clay will flow in all directions under very light load, and should not be loaded more than 3,000 pounds per square foot, while a dry clay will satisfactorily stand a load of 3,000 to 5,000 pounds per square foot. If the foundation is to be placed on *made* ground or *fill*, provision should be made to keep the ground perfectly dry and free from water. With this condition existing a satisfactory foundation can be made, which is more desirable than a wet or oozy clay soil.

When the machine foundation is placed on *clay* or *fill* better results can be obtained by making the foundations cover a larger area rather than making it of greater depth, unless the fill is of such depth that the foundation may be extended through. It must be remembered that when

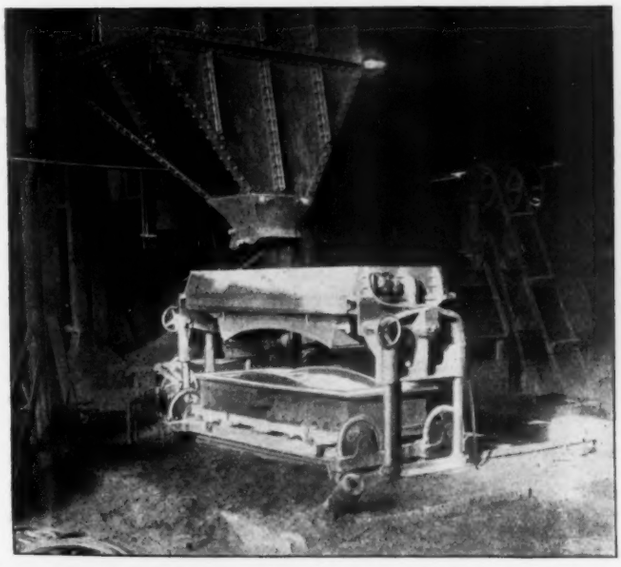


FIG. 7—VIEW OF LARGE, 36 x 150-INCH DIRECT-DRAW ROLL-OVER JOLT MACHINE

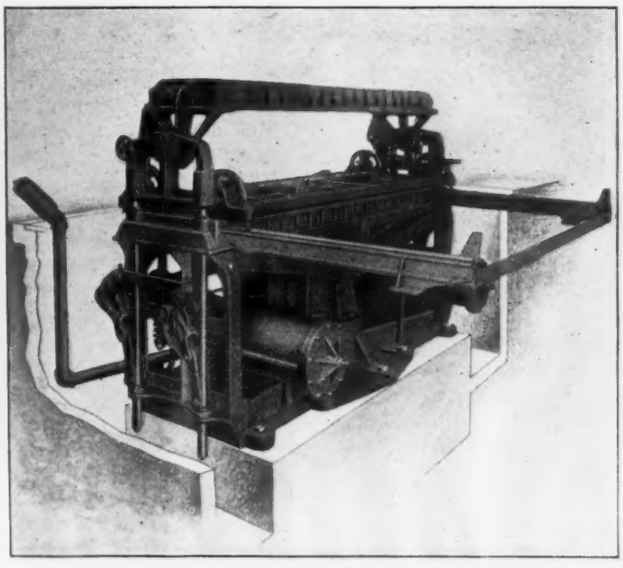


FIG. 8—SAME MACHINE AS FIG. 7, SHOWING SECTION THROUGH FOUNDATION

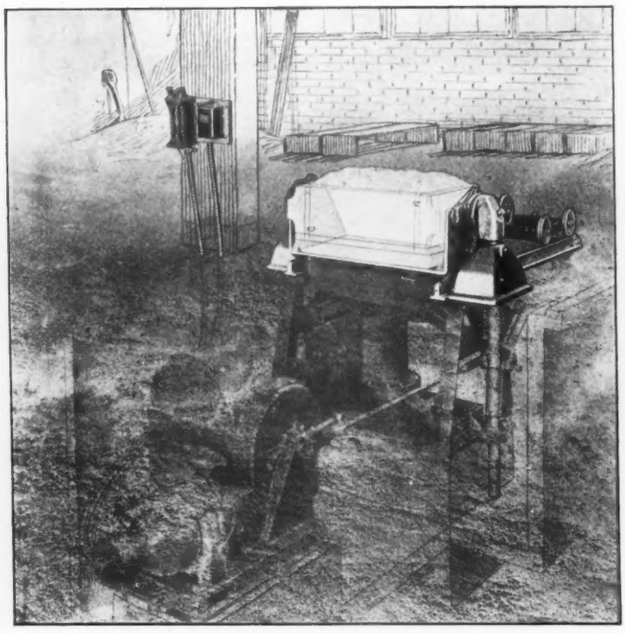


FIG. 9—FOUNDRY FLOOR VIEW OF 42-INCH ELECTRICALLY-OPERATED DIRECT-DRAW ROLL-OVER JOLT MACHINE, WITH BASE AND FOUNDATION SHOWN IN PHANTOM

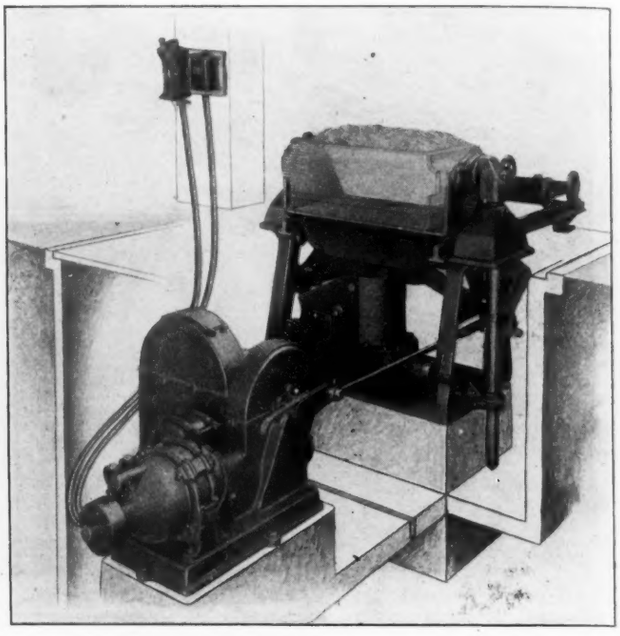


FIG. 10—SAME MACHINE AS FIG. 9, SHOWING SECTION OF FOUNDATION

we place a molding machine in the foundry that we are actually violating the old established principle of machine installation and *placing it in a sand pile* instead of an engine room, or other dirt and dustproof room, and yet notwithstanding this extraordinary condition and without giving the machine proper care, many foundrymen expect as good results from the machine in the sand pile as they do from the machine that was placed in a dustproof room and in charge of an expert mechanic.

The accompanying illustrations will demonstrate that it is economy to provide a foundation and setting that will give ample protection to the machine, by making it impossible for sand to collect on the machine or its moving parts.

The illustrations also show the advisability of providing ample space around the machine so that the mechanic can easily oil, inspect and keep the working parts in order, the same as he does the machine that was placed in the engine room. The depth of the space surrounding the machine should be sufficient for a man to stand erect, suitable lighting facilities should be provided and a stairway or ladder should lead into the pit. The covering of the foundry floor should be made of 2-inch matched planking and should be fitted tight against the machine. The trap door leading into the pit should be hinged and of ample size.

Fig. 1 shows a simple, plain jar-ring machine of such size as not to require a pit, the foundation being only sufficient to hold the machine in place. The design of the machine permits the sand to be filled around the base, as all working parts are protected from the sand and grit.

Fig. 2 is a foundry floor view of jar-ram, power-strip machine, having all of the working parts well protected. Fig. 3 is the same machine as Fig.

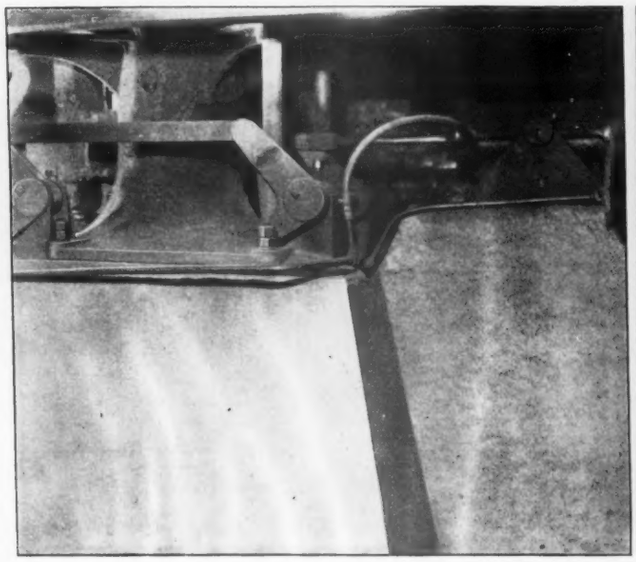


FIG. 11—JAR-RAMMING MOLDING MACHINE SET ON A PIER

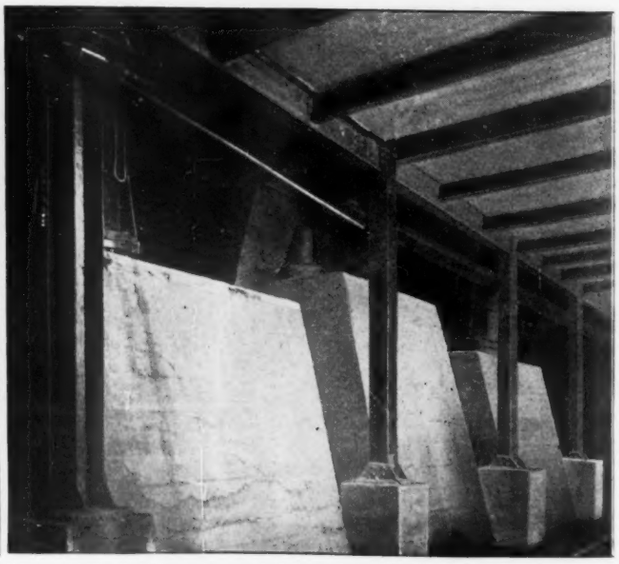


FIG. 12—JAR-RAMMING MOLDING MACHINE FOUNDATIONS AT THE PLANT OF THE CENTRAL FOUNDRY CO., HOLT, ALA.

2, showing the simplicity of the foundation.

Fig. 4 is a section through the base and foundation of a large 42 x 97-inch plain jar-ramming machine.

Fig. 5 is a foundry floor view of

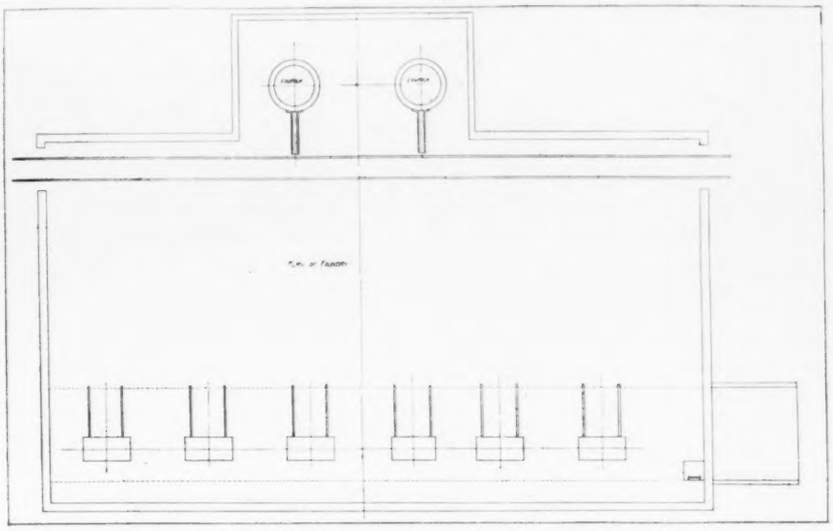


FIG. 13—PLAN VIEW OF A PROPOSED FOUNDRY HAVING A TUNNEL OR BASEMENT FOR SETTING MACHINES

54-inch, direct-draw, roll-over jolt molding machine.

Fig. 6 is the same machine as Fig. 5, showing a section through the foundation.

Fig. 7 is a foundry floor view of a large 36 x 150-inch, direct-draw, roll-over, jolt molding machine.

Fig. 8 is the same machine as Fig. 7, showing a section through the foundation.

The foundations shown in Figs. 6 and 8 illustrate clearly the necessity for providing suitable space around the machine, and also the advantage to be gained by placing the machine base on a pier, thereby making it possible to keep the machine free from sand or dust accumulation.

Fig. 9 is a foundry floor view of a 42-inch electrically-operated, direct-draw, roll-over jolt molding machine with base and foundation shown in phantom. Note the position and simplicity of controllers.

Fig. 10 is the same machine as Fig. 9, showing section of the foundation and illustrating clearly the provision made for the motor base. Note that the foundation of the machine and of the motor base are cast separate, thus preventing the vibrations from reaching the motor.

Fig. 11 is a view taken at the plant of the American Steel Foundries, Alliance, O., showing the advantage to be gained by setting the machine on a pier. Note the freedom from dirt and dust.

Fig. 12 is a view taken at the plant of the Central Foundry Co., Holt, Ala., showing the most approved manner of providing foundations. The cylinders of the machines extend through the ceiling of this basement leaving only the jolt table exposed on the molding floor above. Seven machines are in this row, all of which are readily accessible.

The engineer or architect called upon to design and build the foundry of tomorrow will do well to thoroughly consider the best method of installing and maintaining the molding machines to be used, placing them in such a manner as to insure ample protection from dust and grit, making it easy to give the machine the care and attention it deserves.

The author's idea of a foundry that will best meet these requirements is set forth in Figs. 13 and 14. These illustrations show the plan and cross-section of a proposed foundry, having a tunnel or basement extending the full length of the molding floor. The floor of this tunnel or basement should be at least 7 feet below the ceiling and the width should be sufficient to allow a clear passageway on one side of the machines; the piers for the machine foundations can be placed at any time and to suit any condition.

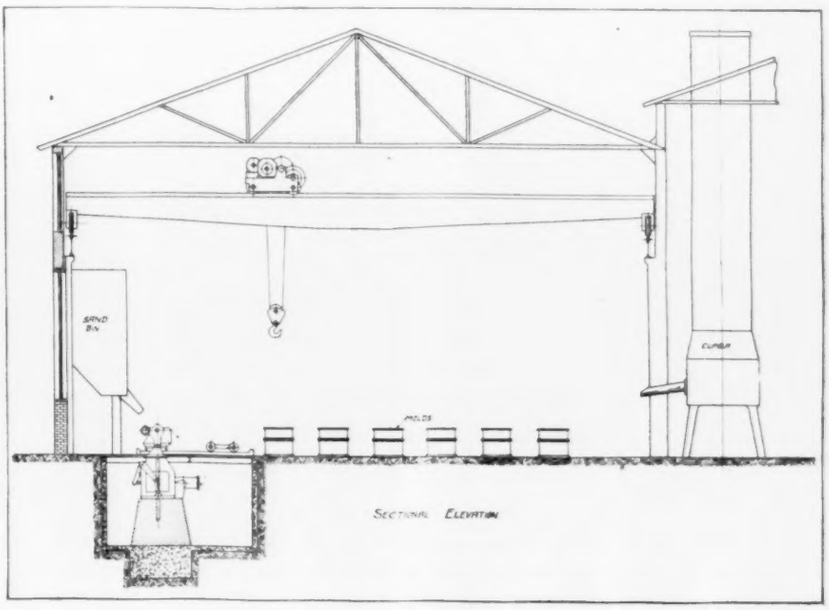


FIG. 14—CROSS-SECTION OF THE PROPOSED FOUNDRY

Displays Safety Glasses

The exhibit of safety glasses displayed by T. A. Willson & Co., Inc., Reading, Pa., at the Panama-Pacific exposition, has attracted favorable comment. Twelve different styles of these goggles, adapted for use by grinders, machinists, furnacemen and welders, are shown. Different styles of metal and leather shields also are displayed. An interesting feature is an exhibit of one pair of goggles which has been broken purposely in order to illustrate the protection afforded by the rim which prevents broken glass from falling back into the eye of the workman.

The Ajax Sand Co., Erie, Pa., has been incorporated with $10,000 capital to engage in the mining and shipping of molding and silica sand for foundry operations. Banks are located at Greenville and Oil City, Pa. The latter plant is now producing 400 tons of silica sand per day, which is largely being shipped to the steel-casting trade. The officers of the company follow: W. L. Scott, president and general sales manager; T. B. Ely, treasurer, and F. H. Flowers, secretary.

Tests in Atomizing Fuel Oil With Steam and Air

Results of an Investigation to Ascertain the Relative Economies of These Methods as Applied to Open-Hearth Furnaces

By R A Bull

THE committee on steel foundry standards of the American Foundrymen's Association, at the suggestion of the writer, who was interested in the subject and offered facilities for research at the plant of the Commonwealth Steel Co., Granite City, Ill., undertook during the past year an investigation into the relative advantages and disadvantages of atomizing fuel oil with steam and air in open hearth steel furnaces. Subsequently, the American Steel Foundries kindly tendered the use of their Indiana Harbor, Ind., plant for making the tests in an acid furnace. The desire was to determine which of the two atomizing agents is preferable from every standpoint including cost, time, quality of product, etc., both in basic and in acid practice. It is of course necessary to summarize the basic and acid tests separately, and it has seemed most satisfactory for each series of tests to be reported by the member who gave the tests his constant general supervision, and who was consequently in closest touch with all details of the investigation. Accordingly, what immediately follows is the result of basic tests made under the general direction of R. A. Bull, who acknowledges the valuable personal assistance, on the ground, of W. C. Hamilton, of the American Steel Foundries, Granite City, Ill., and W. A. Janssen, of the Bettendorf Co., Davenport, Ia. The basic tests were under the immediate observation of E. R. Swanson, assisted by John H. Locke and others of the Commonwealth Steel Co.

The tests were begun March 29, this year, at the plant of the Commonwealth Steel Co., on an open hearth furnace having a magnesite bottom, the bath of this furnace at the slag line being 21 feet 4 inches by 9 feet 6 inches in area, and 21 inches deep at the center, 2 feet back of the tap hole. The furnace at the time of the tests was receiving initial charges of pig iron and scrap amounting to 56,000 pounds. The exact time for beginning the tests was purposely regulated by the condition of the furnace, on which test operations were begun when it was in perfect normal condition, in the middle of its campaign. It had made 275 heats since the last general repairs. The furnace presented no extraordinary details of construction from those usually found in steel foundries, and had no water cooling equipment. The furnace stack was 100 feet high, and had an inside diameter of 48 inches. The oil burner is shown in Fig. 1. The oil was delivered to the burners at a pressure of 95 pounds per square inch, and the effect of pump pulsations was counteracted by a standpipe and air cushion.

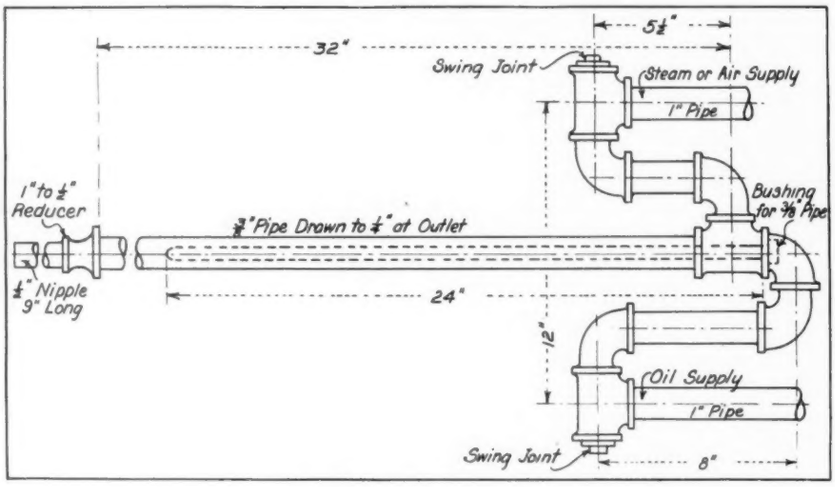


FIG. 1—DETAIL OF OPEN-HEARTH OIL BURNER

Oil Used

The oil used was that which is commercially known as fuel oil and came from fields near Lawrenceville, Ill. Samples for B. T. U. determinations were taken at 6-hour intervals throughout the tests. They proved so uniform that no corrections were considered necessary in the figures for oil consumption. The average B. T. U.'s per pound were found to be 19,066, and the average specific gravity was 0.914, which closely corresponds with 23 on the Beaume scale. This oil is of very satisfactory quality for open hearth use and averages about 0.33 per cent sulphur. A temperature of 125 degrees Fahr. for the oil was adopted and maintained throughout the tests, as preliminary observations indicated no improvement at lower or higher temperatures.

All instruments were carefully calibrated just prior to tests and immediately following them, and any necessary corrections were made as shown advisable by the calibrations. These corrections were found to be of very slight importance in any case, due to the accuracy of all the instruments used.

Both steam and air were measured by a General Electric recording interchangeable flowmeter having an integrating attachment. Three separate calibrations of this instrument showed an average error of 0.2 per cent plus. The uniformity of the results in these calibrations was marked and the accuracy of the instrument was very gratifying.

The oil consumption was measured by a Bowser meter, which together with the instruments enumerated below and not otherwise noted are the property of the Commonwealth Steel Co., and have given satisfactory service. Draft pressure and flue temperature at the base of the stack, also temperature of the oil were determined by Bristol recording instruments. The temperature of the bath in the furnace was taken by a Scimatco optical pyrometer. The uniformity of the oil temperature was maintained by means of a Sylphon automatic temperature regulator. The burners and furnace valves were reversed on signal from an automatic alarm attached to an ordinary clock. The time when valves

Presented at the Atlantic City meeting of the American Foundrymen's Association.

and burners were actually reversed was determined by a recorder made by the Eco Magnetic Clock Co. The tensile tests were made on a Riehle 100,000-pound machine, and on an Olsen 100,000-pound machine owned by the American Steel Foundries. Two sets of bars were made, one having rough turned grips, and the other having threaded grips. The apparent elastic limit on the threaded bars was determined by means of a modified Berry strain gage having a two-point contact, reading 0.0001 inch and owned by the American Steel Foundries. The Johnson method was employed in plotting curves representing the stretch of the threaded test pieces. The threaded bars were pulled on the Olsen machine. The bars with rough turned grips were broken on the Riehle machine, and the yield point of these bars was determined by the drop of the beam.

Many expedients were suggested and tried for determining the loss by oxidation. These resulted in a very satisfactory method for weighing the ladleful of steel on a Fairbanks 5,000-pound rolling mill scale, arranged as shown in Fig. 2. This scale was calibrated several times by placing objects of determined weights in varying amounts on the platform designed for the ladle, to check calculations and verify the belief of the Fairbanks representative that the mill scale would accurately register the expected overload. The average of several test-weighings which were reasonably uniform showed the following results, from which a curve was plotted for the correction of weights observed:

Load on scale, pounds.	Error, per cent.
51,986	1.2 plus
59,966	1.7 plus
74,473	1.93 plus
81,453	2.44 plus

The amount of metal represented in any *back pits* rabbled out of the spout after removal of the ladle was added to the weight of the filled ladle, and after the heat had been poured any sculls remaining were taken into consideration in determining the tare weight, which included not only empty ladle, but stopper-rod and slag. The scale was placed within 50 feet of the furnace on the pouring floor, and the weight of the ladle was determined with a loss of only a few moments' time. It will be observed that the length of the lever arm readily adapted the use of a scale of such small capacity for this work. The knife edges for the beams were especially made of hardened tool steel. A substantial temporary foundation was placed under all parts of the scale, and a level condition maintained. The bail was removed from the trunnions before the weight was taken.

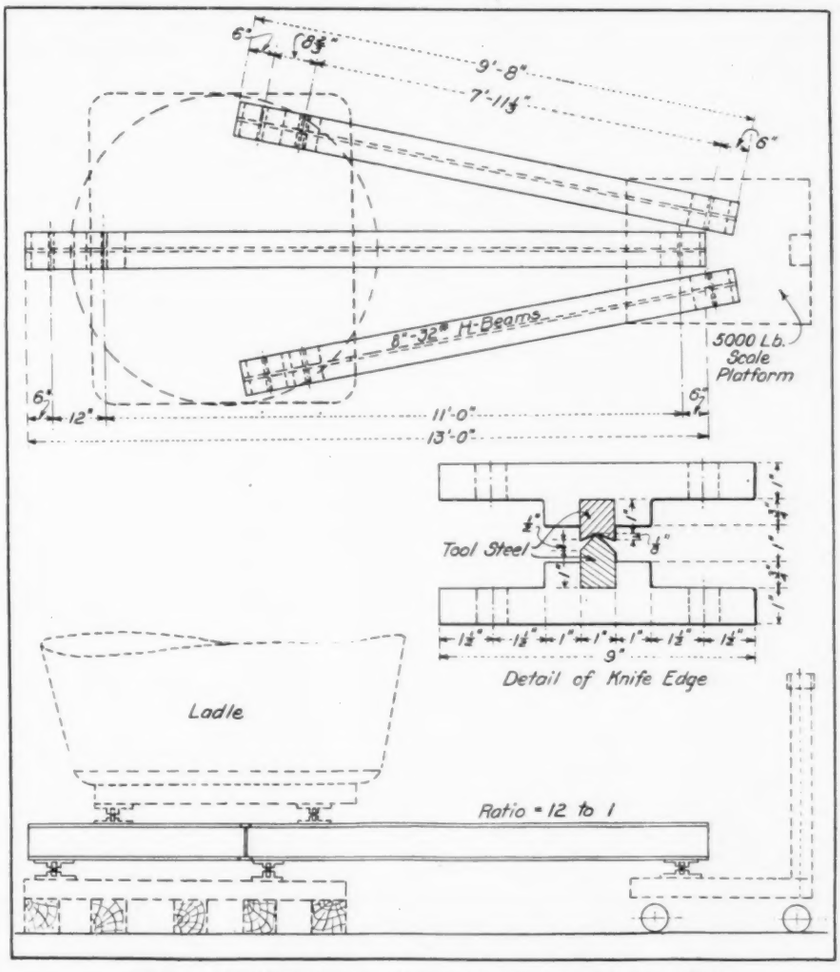


FIG. 2—ARRANGEMENT FOR WEIGHING STEEL IN LADLE

A draft at the base of the stack representing 0.8 inch of water was adopted and maintained throughout the tests, as this was by previous observation believed to be most satisfactory. Periods for reversal of furnace burners and valves were at 15-minutes intervals, being so regulated as determined by previous experiments.

In the steam tests, the atomizing agent was delivered from boilers showing 125 pounds gage pressure and was superheated by passing through a coil 24 feet long, made of 1-inch pipe, placed through the flue just outside the damper and throttled to a pressure varying from 40 to 60 pounds as desired at the burner. A pressure of 60 pounds was maintained until the stock was melted and the pressure was then reduced to 40 pounds to finish the heat. The degree of superheat varied somewhat and averaged 140 degrees Fahr., which was considered to be conservative for yielding the best results, as ascertained from experience. All members of the committee unhesitatingly agreed that the steam should be superheated, as otherwise there would be reduced efficiency due to saturation, the degree of which would vary greatly in different plants due to distances from boiler rooms and other local conditions. In the air tests, the compressed air was delivered from a receiver showing 80 pounds gage pressure and throttled to a pressure of from 40 to 60 pounds as desired at the burner. The average temperature of the air was 97 degrees Fahr.

In computing oxidation losses, all the iron content found to be representative of the following materials used in the heats was taken into account:

	Per cent iron.
80 per cent ferro-manganese..	12.726
50 per cent ferro-silicon.....	40.43
12 per cent ferro-silicon.....	86.154
Iron ore	66.438

The amount of metal charged included not only the iron content in these materials, but of course any pig iron found necessary to add after melting. Pig iron and scrap were debited at 100 per cent. The yield was re-

Table I
Details of Heats Treated with Compressed Air

Consecutive heats from furnace since last repairs.	Weight charged, pounds.	Weight tapped, pounds.	Oxidation loss, per cent.	Temperature of surface of bath, 10 minutes before tap, degrees Fahr.	Oil consumed, gallons.	*Air consumption, cu. ft.	Time of heat, charge to tap, hours minutes.
275	57837	53150	8.10	3170	1182.0	62205	7:45
277	57957	53040	8.48	3200	1158.2	57893	7:20
278	58431	54000	7.59	3200	1201.2	65406	7:31
281	58371	53675	8.04	3200	1312.2	61654	7:45
282	57140	52630	7.89	3150	1202.8	64679	8:00
283	58001	53263	8.16	3150	1205.6	60206	7:35
284	58417	53840	7.83	3170	1150.3	65909	7:35
285	57837	52890	8.55	3225	1161.1	62291	7:28
286	57714	53462	7.36	3200	1226.2	57806	7:40
287	57419	52955	7.77	3160	1215.1	67838	8:05
288	57887	53132	8.19	3200	1211.0	63908	7:50
307	57671	52683	8.65	3250	1236.3	62728	8:05
308	57871	53352	7.89	3150	1299.8	60368	8:30
309	57883	53300	7.91	3300	1192.6	58847	7:55
310	57769	53320	7.69	3200	1206.5	59988	7:50
Average	57880	53246	8.006	3195	1210.7	62115	7:47

*Air consumption on a basis of free air at 14.7 pounds absolute and 70 degrees Fahr.

garded as 100 per cent of the steel produced.

In each heat 31,000 pounds or 55.3 per cent of chill cast northern pig iron, 17,000 pounds of reasonably heavy foundry scrap, 8,000 pounds of scrap rails, and 8,400 pounds of limerock were initially charged. An average analysis of the pig iron shows the following:

	Per cent.
Carbon	3.250
Phosphorus	0.159
Sulphur	0.040
Manganese	1.030
Silicon	0.840

An average of numerous samples of scrap rails used, shows the following:

	Per cent.
Carbon	0.330
Phosphorus	0.108
Sulphur	0.067
Manganese	0.800
Silicon	0.050

The average carbon content in the foundry scrap was 0.20 per cent, and the percentages of other elements can be assumed to agree closely with the averages noted in the steel produced during the tests. Purposely the quality and physical characteristics of the metal charged were maintained uniform and the variable constituents kept low in all the heats so far as conditions permitted, in order that oxidation loss, quality of metal, etc., might be gaged intelligently.

Heats Treated With Compressed Air

It is instructive to give some detailed figures as well as averages in the log of observations. The tabulated results in Table I are self-explanatory. Determination in all heats for constituents of slags were made and are indicated by the following summary:

	Average, Per cent.	Minimum, Per cent.	Maximum, Per cent.
SiO_2	12.66	11.06	14.37
CaO	52.32	51.28	54.23
Al_2O_3	1.76	0.82	3.06
Mn_3O_4	5.22	3.04	6.59
P_2O_5	1.49	1.38	1.59
S	0.08	0.05	0.11

The analyses of FeO, Fe_2O_3, and MgO were considered sufficiently important to justify recording in full:

FeO Per cent.	Fe_2O_3 Per cent.	MgO Per cent.
13.97	2.83	11.74
15.48	1.42	8.82
16.66	0.25	10.39
13.04	4.55	9.66
13.77	0.36	9.27
14.46	4.23	6.94
17.56	5.34	6.08
15.88	5.30	5.65
14.38	3.23	6.81
13.86	5.13	7.83
11.69	5.74	7.35
17.12	3.74	6.96
14.34	3.56	9.64
14.88	4.38	6.66
15.60	5.19	5.07
Average. 14.84	3.68	7.93

The physical and analytical tests showed the expected uniformity and it would be superfluous to show them in detail. No heat treatment whatever was given any of the test specimens, which insured accurate comparisons of the metal as delivered from the furnace. The average analyses and physical results of tests taken from the middle part of each heat are as follows:

	Per cent.
Carbon	0.2030
Phosphorus	0.0140
Sulphur	0.0226
Manganese	0.7530
Silicon	0.3700

Threaded Grip Bars (Modified Berry Strain Gage)

Johnson's elastic limit per square inch, pounds	20,216
Tensile strength per square inch, lbs.	67,924
Elastic ratio, per cent.	29.7
Elongation in 2 inches, per cent.	31.5
Reduction of area, per cent.	49.2

Rough Turned Grip Bars (Fall or Beam Observed)

Yield point per square inch, pounds.	43,540
Tensile strength per square inch, lbs.	69,338
Elastic ratio, per cent.	62.6
Elongation in 2 inches, per cent.	31.1
Reduction of area, per cent.	51.6

No apparent unusual effect was observed on the roof or bottom of the furnace, nor was any difficulty experienced at any time in making these heats. The average amount of magnesite, which was largely used for bottom repairs, was 660 pounds per heat.

On the assumption that in many plants it costs 2½ cents to compress and deliver 1,000 cubic feet of air at a pressure of 80 pounds, the average cost of compressed air can be figured at $1.55 per heat.

Unintentionally samples of slag were taken from only 14 of 15 heats atomized with steam and the determinations are summarized below:

	Average, Per cent.	Minimum, Per cent.	Maximum, Per cent.
SiO_2	12.75	11.37	14.42
CaO	52.83	50.77	55.19
Al_2O_3	2.54	1.25	3.58
Mn_3O_4	5.54	5.08	6.02
P_2O_5	1.56	1.44	1.70
S	0.06	0.03	0.11

FeO Per cent.	Fe_2O_3 Per cent.	MgO Per cent.
14.66	2.46	5.02
14.72	3.89	5.80
14.97	3.25	5.32
14.31	3.38	5.34
15.66	4.68	4.66
14.79	3.27	5.60
16.73	4.22	5.68
15.74	4.06	5.76
15.97	2.90	7.71
16.27	2.59	5.30
14.37	3.53	6.18
16.08	3.24	6.63
15.44	4.06	5.89
15.68	5.59	5.87
Average. 15.39	3.65	5.56

The physical and analytical tests showed the same degree of uniformity as observed in the metal on which air

Table II
Details of Heats Treated with Steam

Consecutive heats from furnace since last repairs.	Weight charged, pounds.	Weight tapped, pounds.	Oxidation loss, per cent.	Temperature of surface of bath, 10 minutes before tap, degrees Fahr.	Oil consumed, gallons.	Steam consumption, pounds.	Time of heat, charge to tap, hours minutes.
290	57890	53276	7.97	3200	1154.6	3146	7:30
291	57273	52547	8.25	3200	1203.9	3308	8:00
292	57299	53275	7.02	3175	1225.7	3669	7:55
293	58057	53476	7.88	3150	1115.4	3078	7:40
294	57986	52873	8.81	3200	1280.8	3375	7:43
295	58322	53642	8.02	3175	1208.2	3254	7:48
296	57227	53131	7.10	3200	1257.0	3567	8:20
297	57592	53340	7.38	3075	1216.5	3592	7:35
298	57449	53230	7.34	3175	1207.8	3378	7:35
299	57874	53564	7.44	3150	1212.9	3820	8:00
300	57750	53800	7.08	3050	1211.2	3939	8:15
301	57303	53200	7.16	3200	1218.9	3757	7:50
302	57863	53766	7.01	3175	1214.5	3448	7:57
303	57660	52912	8.23	3150	1200.3	3687	8:15
304	58370	54240	7.07	3250	1168.9	3389	7:50
Average	57727	53351	7.58	3169	1206.4	3493	7:52

was used. The test bars were unannealed. The average results follow:

	Per cent.
Carbon	0.197
Phosphorus	0.0133
Sulphur	0.0239
Manganese	0.737
Silicon	0.357
Threaded Grip Bars (Modified Berry Strain Gage)	
Johnson's elastic limit per square inch, pounds	19,821
Tensile strength per square inch, lbs.	65.682
Elastic ratio, per cent.	30.1
Elongation in 2 inches, per cent.	30.4
Reduction of area, per cent.	48.0
Rough Turned Grip Bars (Drop or Beam Observed)	
Yield point per square inch, pounds.	42,764
Tensile strength per square inch, lbs.	67,465
Elastic ratio, per cent.	63.3
Elongation in 2 inches, per cent.	31.1
Reduction of area, per cent.	51.8

The condition of the furnace in every respect checked satisfactorily with the condition when air was used. The average amount of magnesite used for patching bottom was 350 pounds per heat.

On the assumption that in many plants a cost of 14 2/5 cents is representative for generating 1,000 pounds of steam and delivering it at a gage pressure of 125 pounds, the average cost of steam used in atomizing each heat is $0.403.

Other Details of Tests

In making physical tests on the bars having threaded grips, and on which the modified Berry strain gage was used, a cross-head speed of 0.025 inch per minute was maintained until the apparent elastic limit was reached, after which the speed was increased to 0.78 inches per minute, and maintained until rupture occurred. The bars having plain turned grips were pulled at a cross-head speed of 0.59 inch per minute throughout.

No unusual characteristics of the metal when being poured were observed at any time. Purposely, all heats which were made under any undesirable or abnormal conditions were eliminated, as for example, any in which bottom troubles occurred. Observations of the furnace indicated the desired consistency of operations throughout the 30 heats tested. Observers were detailed to follow every operation throughout the 24 hours of each day, and all observations were carefully charted.

It had been the purpose to supplement this report by photo-micrographs, but there could be no relation whatever established by examination of numerous etched unannealed specimens from these basic heats, under a microscope owned by the American Steel Foundries, and illustrations of the microscopical views would therefore be superfluous. Structures as observed and recorded appear to be perfectly normal.

A comparative summary of results is given in Table III, all items being averages: Analysis of the tests herein reported indicates that no relation can be drawn between the results with either superheated steam or compressed air as to the quality of the metal produced, time required for making heats, oil consumption, or temperatures secured.

Deductions

It seems possible that there is a relation as to effect on the furnace bottom in view of the fact that the average content of magnesium oxide in the slag on the heats treated with air averaged 42.6 per cent higher than in the case of steam treated heats. The absorption of more magnesite into the slag on the air-treated heats as shown by the slag analysis, seems to tally with the increased amount of magnesite required for bottom patching on these heats.

Although the oxidation losses in the two groups of heats did not vary greatly, the advantage is in favor of steam-treated heats, in which there were apparently about 244 pounds of metal recovered per heat, which was lost when atomizing with air.

As to comparisons of final costs, each plant of necessity must form its own conclusions, arriving at them by the local costs for compressed air and superheated steam as well as by comparative data given. These data may not in every respect seem entirely conclusive to all students of open-hearth practice, but are believed to be more reliable for purposes of comparison than anything heretofore publicly reported. Characteristic local conditions must always be taken into consideration, and in respect to these, it is pertinent to emphasize that the 15 heats treated with air were manipulated by the same crews that handled the same number of heats treated with steam, and that there was no prejudice on the part of furnacemen or observers conducting the tests, and abundant opportunity for the closest supervision.

Since the cost of delivering the required amount of air would be invariably higher than that entailed by the delivery of the required amount of steam superheated by any such economical means as is here reported, there would seem to be a considerable commercial advantage in employing superheated steam as an atomizing agent in basic open hearth practice, with no loss to the quality of the product.

There will be observed a striking divergence between the yield point determined by the drop of the beam and the apparent elastic limit as determined by the use of the modified Berry strain gage and the method described in J. B. Johnson's "Materials of Construction". This divergence of results emphasizes the necessity for defining exactly not only what is meant by the term *elastic limit*, but the means employed for ascertaining such limit. Comparisons are absolutely valueless without information on these points, as fittingly observed by T. D. Lynch in his paper read before the American Society for Testing Materials this year.

Table III

Comparative Summary of Results.

	Air.	Steam.
Weight charged per heat, pounds	57,880	57,727
Weight tapped per heat, pounds	53,246	53,351
Oxidation loss, per cent	8.006	7.58
Time per heat, charge to tap, hours and minutes	7:45	7:52
Oil used per heat, gallons	1210.7	1206.4
Amount of air used per heat, cubic feet	62,115	.....
Amount of steam used per heat, pounds	.....	3,493
Johnson's elastic limit (Berry gage), pounds	20,216	19,821
Yield point (drop of beam), pounds	43,540	42,764
Tensile strength, threaded grip, pounds	67,934	65,682
Tensile strength, plain grip, pounds	69,338	67,465
Elastic ratio (Berry gage), per cent	29.7	30.1
Elastic ratio, (drop of beam), per cent	62.6	63.3
Elongation, threaded grip, per cent	31.5	30.4
Elongation, plain grip, per cent	31.1	31.1
Reduction of area, threaded grip, per cent	49.2	48.0
Reduction of area, plain grip, per cent	51.6	51.8
Carbon, per cent	0.203	0.197
Phosphorus, per cent	0.014	0.0133
Manganese, per cent	0.755	0.737
Silicon, per cent	0.37	0.351
Sulphur, per cent	0.0226	0.0239
Temperature of bath 10 minutes before tap, deg. Fahr.	3,195	3,169
Flue temperature, deg. Fahr.	1,139	1,112

The American Steel Foundries, Chicago, has completed the installation of a six-ton electric furnace of the Heroult type at its Indiana Harbor, Ind., plant.

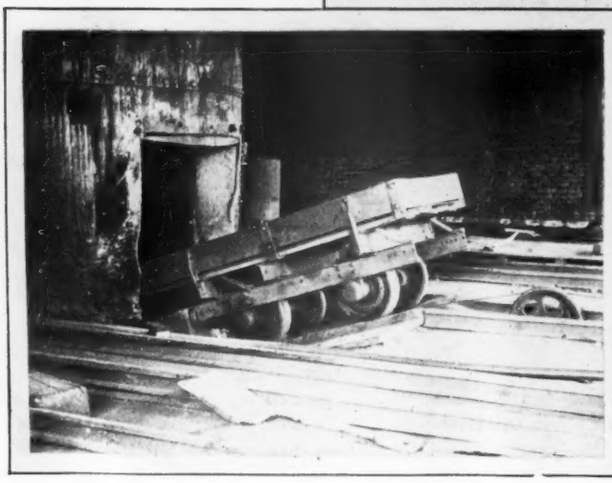
"Foundry Filosofy" is the title of a breezy little booklet issued by the Hill & Griffith Co., Cincinnati. Among numerous features, it contains interesting hints on foundry practice and considerable information regarding the products of the Hill & Griffith Co., including ventilated and perforated chaplets, core compound, plumbago, partings, facings, etc., is presented.

Making Car Wheels at Lenoir Car Works---II

The Melting Practice, Giving Details of How the Mixtures Are Made and the Cupola Charged—Coke Specifications

By G S Evans

THE preceding article published in the September number of *The Foundry*, page 351, described the beginning of the application of scientific principles in the car wheel foundry of the Lenoir Car Works, Lenoir, Tenn. Investigations to ascertain the most suitable mixture for cast iron wheels were discussed and the method of figuring the charge was pointed out. Having determined upon the charge, the next and most important step in foundry operations is the melting. Although involving the application of scientific principles throughout its operation, the cupola too seldom is under scientific control. In fact, it might be said that in many cases the cupola controls the melter and he, in turn, blesses-out the coke, the mixture, or something else which the manager is unable to comprehend.



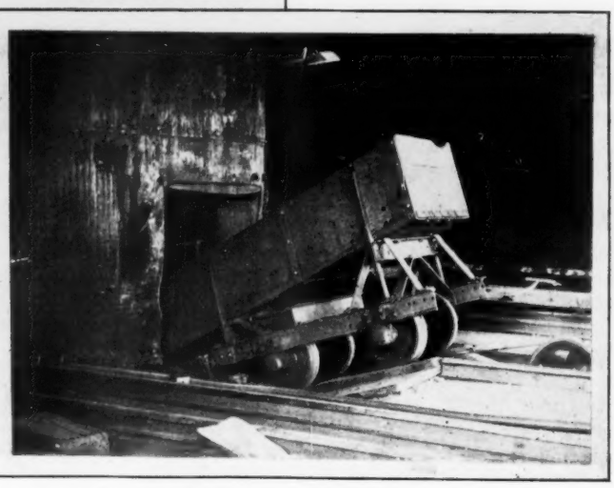


FIG. 1—CHARGING DEVICE OR INCLINE TO THE CHARGING DOOR

FIG. 2—CHARGING BUGGY FOR IRON. TWO BUGGIES MAKE ONE CHARGE

FIG. 3—CHARGING BUGGY FOR COKE, ONE TO EACH CHARGE

The ultimate end of good cupola practice at any foundry is the production of molten metal suitable for the work and at the least possible cost. However, quality is the essential factor in car wheel iron and any deviations from *good*, not only materially weakens the wheels, but is liable to increase shop losses and probably will result in rejections by the inspector. Therefore, best quality at any melting ratio is the cheapest in the end. The practice that will be described has been evolved as a result of continued experiments which are still going on; and it, insofar as has been determined, best meets our requirements.

The cupola was designed and built by the company. The shell is 104 inches in diameter and is lined down to 84 inches, with 4-inch brick next to the shell and extending throughout its length. A 6-inch block inner lining extends 4 feet above the charging door of the cupola. A special feature of the design is the large wind box, or air chamber, built onto the shell. This has an area equivalent to five times that of the wind pipes leading to the cupola, forming a reservoir which tends to equalize the air pressure, thereby delivering air into the melting zone at a uniform rate. The air pipes enter the wind box at a tangent, which also has a tendency to maintain a uniform pressure. Another especial feature is the height of the tuyeres above the sand bottom, forming a reservoir capable of holding ten tons of molten metal which has the advantage of mixing the iron from several charges in one tap. This tends to overcome irregularities in the composition of the metal due to differences in the melting time of the different components of the charge and also equalizes any variations in the charges.

Air is supplied by a horizontal positive blower having a displacement of 65 cubic feet of free air per revolution, driven by a variable speed motor with which it is possible to control the amount of air delivered to the tuyeres. The air is conveyed 90 feet to the cupola through a 25-inch pipe. The eleven tuyeres are placed 30 inches above

the sand bottom. They are 12 x 5½ feet and are arranged in a single row around the cupola, the openings covering 50 per cent of the inside circumference of the lining and the sum of the area of all the tuyeres is equal to about one-seventh the total area of the cupola. The charging door is 12 feet above the top of the tuyeres. The cupola is chipped out clean before each heat; any holes or depressions are filled with small pieces of burnt fire brick varying in size from small pieces to a 4-inch brick. This is accomplished by first daubing the hole with a ganister composed of one part burnt sand and two parts fire clay, mixed to a thin, putty-like consistency. The pieces of brick are forced into this, holding them in place. After all the depressions are filled, the entire melting zone is covered with a thin coating of ganister, slicked down with a wet brush. This method greatly increases the life of the melting zone and at the same time disposes of all burnt fire brick.

The sand bottom is 4 inches thick at the center of the furnace with a 2-inch fall from the opposite side of the cupola to the tap hole. It is made up of a 2-inch layer of fine coke, next to the doors, which is gathered up from the preceding bottom and sifted through a No. 2 mesh riddle. This is covered with a 2-inch layer of gangway sand (burnt molding sand) and is firmly tamped.

Split pine wood of a fairly uniform size is used exclusively for lighting the bed, as it has been found that mixed woods will not give uniform results throughout the bed owing to their variations in burning qualities.

Marble spalls of the following analysis are used as a flux:

	Per cent.
Silica	0.40
Alumina	0.43
Lime	99.00

This is an extra pure grade of limestone, and when used in the correct proportions, gives excellent results, forming a good, fluid slag. Usually 80 pounds, or 1.33 per cent is added to each charge.

Strong, porous coke and plenty of wind which must be under the control of the melter, are the two prime essentials to good melting practice. Two factors govern the value of everything, namely, price and quality, and this is especially true of foundry coke. Poor quality coke is high at any price and good coke is cheap at any price. But to the purchasing agent, *coke is coke*, so that the burden of proof is on the foundryman and considerable experimenting is sometimes necessary to ascertain the value of different cokes.

FIG. 4—FROM LEFT TO RIGHT: CHILL TEST INGOT; SECTION OF 625-POUND WHEEL AND FRACTURE TEST INGOT

Analyses and laboratory tests will help, yet the final and only practical method of deriving the melting value of any coke for the particular work upon which the cupola is run, is to experiment with it in the furnace in daily practice.

Specifications for 72-Hour Foundry Coke

The material desired under this specification is a high grade 72-hour foundry coke having good burdening power and rapid melting qualities. It should be dark gray in color, hard, lustrous and should be free from black ends, braize and ashes.

1—Sample must show on analysis:

	Per cent
Ash, not to exceed	8.0
Fixed carbon, to exceed	89.5
Sulphur, not to exceed	0.5
Moisture, not to exceed	1.0
Volatile matter, not to exceed	1.0
Phosphorus, not to exceed	0.5

2—Must weigh in the bulk not less than 40 pounds to the bushel.

3—Must have a crushing strength of at least 275 pounds per cubic inch.

4.—Samples of one peck each will be taken from each car load of a shipment, the samples added together and thoroughly mixed, and the resultant sample represent the shipment.

5—The analysis will be made according to standard methods and should the sample fail to comply with the specifications, the shipment will be rejected.

6—All rejected material will be held subject to the shipper's disposition and the shipper shall assume all charges on rejected material.

FIG. 5—LENOIR CAR WORKS' SPECIFICATIONS FOR 72-HOUR FOUNDRY COKE

A series of experiments with different brands of coke contiguous to this territory, were conducted coincident with the experiments with the mixtures, published in last month's issue to determine the most economical brand of coke to be obtained in this district. Sample cars of several different brands of coke were obtained, in addition to the regular grade of fuel which was used. Samples of each brand were submitted to laboratory tests, the results being tabulated in Tables I and II. These different brands of coke subsequently were tried out in the cupola, the results of the experiments being tabulated in Table III. Comparing the different brands and following each through the three tables, it will be noted that sample No. 3 is the best quality and consequently it was selected for general use. Specifications for foundry coke, Fig. V, were prepared. These can be met easily by the producers of this particular brand, but eliminate all undesirable grades. The purchasing agent was instructed to buy all coke according to these specifications. All coke charges, except the bed, which is always brought to a standard height in the cupola, are accurately weighed, and when using the coke represented by sample No. 3, the melting ratio will average one of coke to 7.34 of iron over a 12-month period. However, this varies considerably at different times, depending upon the weather, condition of the coke, etc. The fuel ratio generally is lower during the summer months and higher in winter. This is due principally to the high humidity during the summer season in this section. It also varies considerably on dry and wet days and frequently on the same day, depending on conditions that may arise during the heat.

In regular practice, the condition of both the atmosphere and coke is noted before the heat is started, and the charge of coke is made accordingly. The atmosphere is tested for water vapor, with a Sling Psychrometer, and is figured by the psychrometer chart (Marvin) to gallons per 100,000 cubic feet of free air. This determination is made in about five minutes and can be done by any one capable of correctly reading a thermometer. The coke is examined as to its size (relative amounts of small and large particles) and is tested for moisture by collecting a five-pound sample which is pulverized to pass through a No. 6 mesh sieve; it is thoroughly mixed and a one-pound sample is weighed and dried for 40 minutes at 220 degrees Fahr., after which it is cooled and weighed; the loss, taken as moisture, is figured to pounds per 100. After having made these determinations for a short period, the melter soon learns to judge both the

moisture in the air and coke, and is able to make correct allowances without the analyses; however, these are made at intervals to check up his judgment.

It is absolutely essential to good cupola practice that these factors be considered, more especially so where the cupola is running on car wheels, or other castings which require a certain exactness as to chill and strength. In this section of the country, the water vapor of the atmosphere will vary from approximately 3.5 to 14.5 gallon per 100,000 cubic feet and the moisture content of the coke will vary from 0.60 to moisture instead of 0.60 per cent, the charge would be figured as follows: 9—5 or 4 × 8 = 32 pounds to equalize the action of excess water and 1.60 — 0.60 or 1.0 per cent of 820 = 8.2 pounds to allow for the moisture in the coke, making the total coke equal 820 + 32 + 8 or 860 pounds per charge.

Charging Coke and Iron

Both iron and coke are charged by a gravity dumping device, illustrated in Figs. 1, 2 and 3. Figs. 2 and 3 show the iron and coke buggies just after being discharged, and Fig. 1 illustrates the dumping device. This is merely an incline down to the charging floor, having stops equipped with heavy coiled springs, arranged to engage the side sills of the buggy which absorb the shock and at the same time throw the buggy back and tends to distribute the charge more evenly over the whole area of the cupola. After dumping, the cone, shown in the center of the rails, Fig. 1, engages the front axle and pulls the buggy out. Each charge of iron is carefully leveled before the charge of coke is made, and this also is leveled before the next charge of iron. This is essential to uniform melting and any irregularities will show up in the chill at once.

LENOIR CAR WORKS—Foundry Dept. Form 109—Revised

DAILY REPORT OF OPERATIONS

Wheel Department Lenoir City, Tenn., July 20 1915

WHEELS MADE AND LOST								WHEELS ON HAND AND SHIPPED		
33"	Wt.		Wt.		Wt.	Made	Bad	Wt.		
60	625#					60	1	625#	Balance on Hand July 19 1915	5349
90	675#					90	1	675#	Wheels Made	300
150	725#					150			Balance	5649
									LESS Test Wheels 3-625# 3-675 3-725	9
									Bad Wheels	2
									Wheels Shipped	0 11
						300	2		Balance on Hand	5638

CUPOLA CHARGING SHEET

Car No.	Location	Brand	Grade	Pounds Per Chg.	No. Chgs.	Total Iron	REMARKS
		Scrap wheels		4700	37	173900	
		Steel bars		300	-	11100	
		Steel punch		200	"	7400	
JC 34103	Bin 3	woodward	M.S.	300	-	11100	
mo 40337	" 6	pioneer	#3	200	"	7400	
mp 36068	" 7	"	#3	300	"	11100	
		Ferro mang.	80%	13½	"	500	
Total				6013½		222500	
LESS Return Scrap						7045	
Net Amt. Used						215455	

CHEMICAL COMPOSITION			
Elements	Gr. Per Cent	Net Weight	207000
Silicon	0.77%	Melting Loss	8455#
Sulphur		Coke to Bed	4840#
Manganese	0.68%	Coke Per Chg.	865#
Phosphorus		Total Coke	36845#
Comb. Carbon		Limestone Per Chg.	80#
Graphite		Total Limestone	2960#
Total Carbon		Blast On:	8.55 a.m.
		First Iron:	9.50 a.m.
		Bottom Dropped:	3.30 p.m.

FIG. 6—DAILY REPORT OF MELTING OPERATIONS

The iron charge is 6,000 pounds throughout the heat from the first to the last charges, made up in two equal parts of 3,000 pounds each. This equals approximately 1.1 pounds of iron per square inch of the cupola area.

The blast pressure usually is maintained at 9½ ounces, but it frequently is raised or lowered to regulate the chilling capacity and strength of the iron during the heat. At this pressure the melting rate is about 31,000 pounds per hour, with an air consumption of approximately 40,000 cubic feet of free air per ton, and the cupola or melting loss averages about 3.8 per cent of the total iron charged.

In starting off the heat, an ample supply of wood is used. When this is laid in in the usual manner, alternating in crosswise layers, it comes up to about 6 inches above the tuyeres; then about two-thirds of the coke for the bed is added and the cupola is lighted. After the wood is completely burned and the bed ignited throughout, sufficient additional coke is charged to bring the top of the bed 32 inches above the tuyeres. Special care is exercised in selecting large coke for the bed and in bringing it up to the proper height over the whole area of the cupola. The furnace is then filled with alternating charges of iron and coke and the blast put on, the first iron appearing in about 14 to 16 minutes.

Tests for Chill

The first and all succeeding taps are tested for chill, using a 1½ x 2½ x 8 inch test ingot, casting the 1½ inch face against a chiller; this is cooled in water as soon as possible after solidification, broken and the chill measured and recorded for future reference.

The mixture given in the "Daily Report of Operations," Fig. 6, is figured to give an iron of the following analysis: Silicon, 0.63 per cent; sulphur, 0.125 per cent; manganese, 0.59 per cent; phosphorus, 0.42 per cent, and carbon, 3.47 per cent. When properly melted it will produce a 1¼ inch chill on the test ingot, with a moderate amount of blending of the chill into the gray portion; the latter will have a dark, even grain fracture without appreciable mottling. When poured at the proper temperature, about 0.6 of the chill of the test ingot will be formed on a 625-pound wheel and about one-half on a 725-pound wheel; this also will show a nice blending of the chilled and gray portions. Furthermore, two fracture test ingots, 2½ x 2½ x 10 inches, are cast in green sand molds, being poured from the first and third part of the heat. These are allowed to cool in the

5.0 per cent. It has been determined that eight pounds of coke extra per charge is required for each gallon increase above five of water vapor, and this amount is added to the charge regularly as required. For each increase of 1 per cent of moisture in the coke, a like addition is made to the fuel charge and, in additions when the run of coke is very small an additional five to ten pounds is added to allow for this variation. For instance taking the charge at 820 pounds under normal conditions, if the air contains nine gallons of water instead of 5, and the coke 1.60 per cent

sand, broken and examined for fracture, after which drillings are taken for the analysis. Occasionally "arbitration test bars," 1¼ inches round and 15 inches long, cast on end in a dry sand mold, are made and tested for transverse strength by breaking with 12 inches between supports, and which usually show a strength of 3,800 to 4,400 pounds. Fig. 4 shows samples of normal chill, fracture test ingots and the fracture of a 625 pound wheel cast from the same mixture. This shows the relation of the chill of the ingot to that of the finished wheel.

Usually enough metal is tapped out in the first tap to pour from 22 to 24 wheels. However, only 16 wheels are poured, the remainder of the metal being left in the reservoir for the dual purpose of being heated by the following tap and to blend one tap into another. This has a tendency to overcome any slight variations in the succeeding taps. This method is pursued throughout the entire heat and usually sufficient metal for about six wheels is left over from the last tap and is poured into pig beds. This eliminates the possibility of getting cold iron, which might be drained from the last iron in the reservoir, poured into the molds, thereby causing weak wheels.

The mixture is figured each day by the chemist and is furnished to the melter, on a blank form as illustrated in Fig. 6, by noon on the day before the mixture is to be used so that the stock can be arranged in position for the next day's heat. The charges are made according to the charging sheet by carefully weighing all the different materials. At the conclusion of the heat, the melter reports the number of charges used, amount of coke, limestone, etc., and the duration and time of the heat on the same form.

The foregoing deals with normal conditions which usually are maintained when the proper care is taken in starting off the heat. However, as everyone familiar with cupola practice knows, innumerable factors affect the operations of a cupola which cannot always be foreseen, such as variations in the analyses of the components and the quality of the materials going into the charge; the coke, variations in starting off the cupola, such as over or under-burning the bed before putting on the blast; misjudging the conditions of the weather and its effect on the heat, mechanical break-downs, etc., any of which will materially affect the chill of car wheel iron. The effect of these is seen in the chill test ingot which is the criterion by which the cupola is operated and by which the melter usually is able to judge as to the trouble and to take steps to correct it.

Table I

CHEMICAL ANALYSIS OF FOUNDRY COKE

Sample, No.	Moisture, per cent	Volatile combustible, per cent	Fixed carbon, per cent	Ash, per cent	Sulphur, per cent	Phosphorus, per cent
1	0.68	0.89	90.31	7.53	0.59	....
2	0.80	3.06	83.78	11.67	0.66	0.03
3	0.66	0.56	92.22	6.17	0.37	0.02
4	1.18	1.02	86.61	10.48	0.70	0.01
5	0.42	1.50	86.59	10.90	0.55	0.04
6	0.76	0.64	83.60	14.20	0.80	....
7	0.64	1.68	85.46	11.80	0.42	....

In the meantime, any iron already tapped or that which will be tapped out before the trouble is remedied, is partially corrected by variations in the molding practice.

The chill test ingot will show up any variations in the melting practice, but to explain just how the appearance of this gives indications of the trouble and the remedies for each would be an endless, as well as an impossible, undertaking. However, the following are listed more as examples to show how close watching of the chill ingot will aid one in controlling the operation of a cupola:

Variations in the mixture, up or down, give a low or high chill.

Over-burned bed usually produces a high chill.

Under-burned bed usually produces a low chill.

Table II

PHYSICAL LABORATORY TESTS OF FOUNDRY COKE

Sample, No.	B. T. U.	Shatter test	Porosity or structure	Size of particles
1	13,146	Fair	Fair	Medium
2	13,185	Poor	Poor	Small
3	13,228	Good	Good	Medium
4	13,222	Good	Good	Small
5	13,176	Good	Good	Medium
6	12,994	Good	Fair	Large
7	13,166	Fair	Good	Medium

Use of fine coke usually produces a high chill.

Use of extra large coke, other conditions being equal, usually produces a low chill.

Excess moisture in the air usually produces a low chill.

Excess of coke usually produces a low chill and insufficient coke usually produces a high chill.

Insufficient air (volume) usually produces a low chill, and an excess, a high chill, which is usually accompanied by excess mottling in both cases.

From the foregoing it will be noted that any number of conditions may cause high or low chill; also, the appearance (fracture) of both the chilled and gray portions of the ingot may indicate the possible cause of any particular variation; for instance, a low chill ingot with a sharp line of demarkation between the chilled and gray iron and with the gray portion of a fairly uniform grain throughout, indicates the presence of an excess of air; the same applies to a close-grain fracture around the edges of the gray portion and larger grains in the center, open fracture, indicates a low chilling mixture (excess of silicon); a low chill with excess blending of the chilled and gray iron, or mottling throughout the gray iron, indicates a low mixture and an excess volume of air; a high chill with mottling throughout indicates an excess volume of air and probably a bad mixture.

Table III

CUPOLA MELTING TESTS WITH FOUNDRY COKE

Sample, No.	Burdening power	Melting ratio[1]	Rate of melting	Size of taps
1	Fair	1 to 7.12	Medium	Large
2	Poor	1 to 6.34	Slow	Small
3	Good	1 to 7.32	Fast	Large
4	Good	1 to 6.93	Fast	Large
5	Poor	1 to 6.70	Medium	Small
6	Good	1 to 6.42	Slow	Large
7	Fair	1 to 6.27	Slow	Small

[1]Melting ratio is exclusive of the bed.

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The meetings of the American Foundrymen's Association and the American Institute of Metals attracted to Atlantic City the largest number of foundrymen ever attending these joint sessions. The displays of foundry and shop equipment also were notable, rivalling those of former conventions both in number and in the high character of the products exhibited. The complete report of the meeting of the American Foundrymen's Association is followed by an equally complete account of the splendid sessions of the American Institute of Metals. Immediately following the convention reports is the description of the exhibits.

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Co-operation Among Societies

THE recent conventions of the American Foundrymen's Association and the American Institute of Metals at Atlantic City were replete with suggestions looking toward closer co-operation between these two great societies and certain other organizations of American business men; similar co-operation also was suggested with at least one branch of the government. Various committees of the American Foundrymen's Association, appointed to formulate specifications for different classes of castings, reported that they had been working with similar committees representing the American Society for Testing Materials and without exception these reports were favorably received and the committees directed to continue their efforts. The American Foundrymen's Association also appointed a committee to co-operate, in conjunction with committees from the Institute of Metals and other technical societies, with the U. S. Bureau of Standards in its extensive research and scientific work conducted for the benefit of American industry. The National Founders' Association was represented at the convention, officially, by its president, who earnestly invited the American Foundrymen's Association to assist in the work of the Joint Conference Boards on safety and sanitation and the training of apprentices. He also suggested that the N. F. A. would be glad to co-operate with the A. F. A. in its project looking toward the employment of a cost expert. The force of the co-operative movement among societies is indicated by the statement, made on the floor of the convention, that even the European war has not completely stopped the efforts of certain American and foreign organizations to agree upon a set of international specifications for various classes of castings.

In brief, societies and organizations, like individuals and corporations, have found that they must co-operate with one another if the greatest results are to be achieved with a minimum of effort. The day when each association worked out its problems alone, with a jealous eye on all other organizations—the "we are sufficient unto ourselves" era—happily, has passed.

As our civilization advances and the problems of mere existence become less serious, the problems of human relations multiply and grow in importance. These problems can be solved satisfactorily only through co-operation of the most efficient kind. It is fortunate, therefore, and augurs well for the future prosperity of the country, that such organizations as the American Foundrymen's Association, the American Institute of Metals, the National Founders' Association, the American Society for Testing Materials, and others, can join hands and apply their combined energies and resources to the settlement of the pressing industrial questions of the day.

Trade Outlook

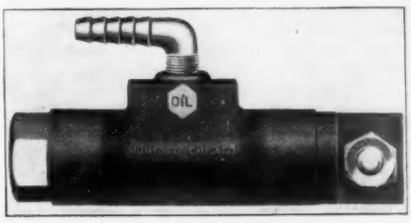
FOUNDRYMEN who attended the recent convention at Atlantic City were almost unanimous in the opinion that business conditions in the casting industry may now be considered normal and that there is every prospect for increased operations as the year draws to a close. Pig iron prices have been advanced and No. 2 foundry is quoted as follows in the leading centers for delivery during the remainder of this year: $15.95, Pittsburgh; $14.25, Chicago; $16.25, Philadelphia; $15.50, Buffalo, and $11.50, Birmingham.

Electric Steel for Munitions

The Thomas Davidson Mfg. Co., Montreal, Can., has placed an order with the Snyder Electric Furnace Co., Chicago, for the installation of an electric furnace which will melt and refine cold steel scrap. The electric steel will be used for casting blanks for the manufacture of shells. This is the second order received for a Snyder furnace for producing steel for use in making war munitions. The other furnace will be installed at Sherbrooke, Can., by the Canadian Brakeshoe Co. The Thomas Davidson Mfg. Co. manufactures stamped utensils and the clipings in the form of scrap, together with other scrap available in this district, will be used as the raw material in the electric furnace.

Pneumatic Vibrator

In the accompanying illustration is shown a pneumatic vibrator manufactured by the Mumford Molding Machine Co., Chicago. The body is



MUMFORD PNEUMATIC VIBRATOR

made of drop forged steel and the piston is carefully ground. A special attachment also can be furnished which is bolted to match boards with an extension permanently bolted to the vibrator, whereby the match boards with patterns attached may be vibrated. The extension on the vibrator is tongued and this fits into the socket of the attachment on the match board. The weight of the vibrator keeps rigid the connection of the extension with the attachment and insures vibration at the proper angle with the face of the mold. This vibrator is made in the following sizes: ½, ⅝, ¾, 1, 1¼, 1½ and 2 inches.

Soft Wood Core Sticks

The New England Novelty Co., Ashland, N. H., is manufacturing soft wood core sticks for use in foundry operations. These can be furnished in various sizes from 1/9-inch in diameter by 4½ inches in length to 1/9-inch in diameter by 12 inches in length. These core sticks are used for strengthening cores, burning out and leaving a vent, and they also can be employed for strengthening molds, replacing nails for this purpose. It is claimed that they hold the sand equally as well as nails and, in addition, they do not become embedded in the metal the same as nails. When the metal comes in contact with the core sticks flush with the surface of the mold, the ends burn off and the casting feeds clean. On the other hand, when nails are used, the heads become embedded in the casting and their removal entails considerable cleaning expense. For core work, the soft wook sticks are intended to replace wire.

Personal

George H. Foley has resigned as superintendent of the Rice, Baron & Fales foundry, Worcester, Mass.

Van H. Manning of Holly Springs, Miss., has been appointed director of the United States Bureau of Mines, succeeding the late Dr. J. A. Holmes.

F. Lee Norton, vice president and general manager of the J. I. Case Threshing Machine Co., Racine, Wis., has resigned and will retire from active business.

R. H. Evans has resigned as general manager of the Frictionless Metal Co., to accept the position of general manager of the Michigan Smelting & Refining Co., Detroit.

R. C. Cheney, foundry manager and superintendent of the Union Foundry Co., Fitchburg, Mass., has accepted a similar position with the Springfield Foundry Co., Springfield, Mass.

R. F. Clark, formerly with the Eagle Glass & Mfg. Co., Wellsburg, W. Va., in the capacity of foreman of the plating department, now is affiliated with the Acme Shear Co., Bridgeport, Conn., in a similar position.

Benjamin J. Lamme, chief engineer of the Westinghouse Electric & Mfg. Co. East Pittsburgh, has been named by Secretary of Navy Daniels as a member of the navy advisory board which will consider questions of national defense.

Asbestos Clothing

Wheeler & Holcomb, 21 East Van Buren street, Chicago, are manufacturing asbestos clothing especially designed for use in foundries to protect workmen against molten metal. The clothing includes gloves, mittens, leggings, aprons, trousers, coats and specialties. The asbestos is specially treated to prevent the nap from rubbing off and the fiber is smooth, which adds to its tensile strength and fireproof qualities. The fabric is sufficiently flexible to allow materials to be handled readily and it is claimed it is not brittle.

New Course at Wentworth Institute

The Wentworth Institute, Boston, has issued a catalog which notes the new developments in industrial education planned for the ensuing year. Two new courses are being added, the first being a one-year day trade course in forging, hardening and tempering. This is intended to give training to young men who wish a thorough knowledge of both hand and machine forging in wrought iron and steel.

The second new course is a one-year day trade preparatory course intended for young men who wish to enter some one of the manufacturing industries but who require a year in which to be tried out to discover in which direction they show special skill and ability. A second year course in architectural construction also is offered for the first time which is intended for training building superintendents, specification men and constructionists for architects and building contractors.

DOUBLE COMPARTMENT PRESSED STEEL CABINET

Pressed Steel Work Cabinet

The pressed steel work cabinet shown in the accompanying illustration, manufactured by the Berger Mfg. Co., Canton, O., provides secure and convenient storage facilities for special dies, tools, blue prints, etc. It is substantially constructed of formed sheet steel and is equipped with a rigid top which can be used for laying-out work or for supporting heavy parts. The cabinet is of such a height that it will fit readily under the mechanic's machine. It is divided into two compartm s with individual locking facilities and one cabinet can serve for a mechanic and his helper. This feature is particularly desirable in plants operating day and night shifts, enabling each mechanic to have one compartment of the cabinet.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The foundry of the G. & F. W. Smith Co., Roxbury, Mass., has been closed.

The Springfield Brass Co., Springfield, Vt., has increased its foundry facilities by the addition of a gray iron shop.

The Wilson Foundry & Machine Co., Pontiac, Mich., has awarded a contract for the installation of 38 core ovens of a new type.

The Globe City Foundry Co., Kansas City, Mo., has been incorporated with $2,000 capital by William J. Barnes, T. J. Sheldon and N. Dee Barr.

The Salmon Bay Foundry Co., Seattle, Wash., has been organized by John Wehn, S. Redick and others at Seattle. A gray iron foundry will be built.

The Chicago Steel Foundry Co., Chicago, has purchased property adjoining its present site to permit further extension to its plant. In the three years since its present foundry has been in operation the capacity has been increased 200 per cent and the ground area 50 per cent.

The Cleveland Silver Manganese Metal Co., Cleveland, has been organized to engage in the manufacture of white metal castings and has leased the plant formerly occupied by the Gordon Propeller Co., C. F. Johnson is president and Emil Kraus is secretary and treasurer of the new company.

New Construction

The H. Root Foundry Co., Chicago, is erecting an addition to its plant.

The Atlas Foundry Co., Marion, Ind., will build an addition, 60 x 150 feet.

The foundry of the C. W. Pond Co., Worcester, Mass., is being enlarged.

The Sivyer Steel Casting Co., Milwaukee, will erect an addition, 75 x 90 feet.

The Universal Castor & Foundry Co. has awarded a contract for a $17,000 addition.

The Hay Foundry & Iron Works, Newark, N. J., will erect a building 37 x 86 feet.

The Nolte Brass Co., Springfield, Ohio, will erect an addition to its plant, 44 x 208 feet.

The H. Mueller Mfg. Co., Decatur, Ill., will erect an addition to its plant, 66 x 152 feet.

The Smith-Matthews Foundry Co., Detroit, will erect a small addition to its plant.

The Kokomo Brass Works, Kokomo, Ind., is erecting two 3-story additions to its foundry.

The Lincoln Brass & Foundry Co., Lincoln, Neb., will build an addition to its foundry.

William Coskey, Philadelphia, is erecting a brass foundry 50 x 90 feet, at Richmond and York streets.

The Pittsburgh Foundry Co., Los Angeles, Cal., is erecting a new shop on East Forty Eighth street.

The Independent Stove Foundry Co., Independence, Mo., contemplates the erection of a stove foundry.

The Wisconsin Bridge & Iron Co., Milwaukee, is having plans prepared for a foundry, 80 x 270 feet.

The Dayton Steel Foundry Co., Dayton, O., is erecting a large addition to its plant in which will be installed an electric furnace, traveling crane provided with a lifting magnet and other equipment.

The American Radiator Co., Buffalo, will erect an addition to its plant at an estimated cost of $55,000.

The West Michigan Steel Foundry Co., Muskegon, Mich., will erect a $25,000 addition to its plant.

The Davis Foundry Co., Hornell, N. Y., contemplates the erection of a 2-story addition, 60 x 100 feet.

The Waclark Wire Works, Elizabeth, N. J., is erecting a brass foundry at an estimated cost of $16,000.

The Shepard Crane & Hoist Co., Montour Falls, N. Y., has awarded contracts for an extension, 125 x 200 feet.

The Hewitt Metal Co., Newark, N. J., is erecting a plant on the site of the buildings recently destroyed by fire.

The United States Smelting & Aluminum Co., New Haven, Conn., will build a 2-story addition, 20 x 40 feet.

Frazer & Jones, Syracuse, N. Y., manufacturers of malleable castings will erect two buildings, 250 x 354 feet each.

The Syracuse Malleable Iron Works, Syracuse, N. Y., will erect an addition to its malleable shop, 110 x 140 feet.

The Pulling Brass Co., Watertown, Conn., has awarded a contract for the erection of a 1 story addition, 50 x 70 feet.

The Sturn Machinery Co., Wheeling, W. Va., contemplates the erection of a foundry. W. W. Krause is manager.

The Buick Motor Co., a branch of the General Motors Co., is contemplating the erection of another large foundry at Flint, Mich.

The Dennison Foundry & Machine Co., Dennison, Ohio will enlarge its plant and is in the market for considerable foundry equipment.

The Albion Malleable Iron Co., Albion, Mich., will increase its annealing department by the erection of an addition, 100 x 200 feet.

The Rome Brass & Copper Co., Rome, N. Y., has awarded a contract for the erection of an addition to its casting shop, 140 x 200 feet.

The Francis & Nygren Foundry Co., Chicago, contemplates the erection of a 2-story addition. W. Tomlinson, Chicago, is the architect.

The D. J. Barker Foundry Co., Brighton, Ont., has awarded a contract for the erection of a new foundry at an estimated cost of $13,000.

The Keystone Steel Casting Co., Chester, Pa., is erecting an addition to its main building. Several open-hearth furnaces will be installed.

The plant of the Moline Malleable Iron Co., St. Charles, Ill., recently damaged by fire, will be rebuilt. Plans for the building have been completed.

The Belle City Malleable Iron Co., Racine, Wis., will install an electric steel melting furnace which will be housed in a building, 80 x 160 feet.

The Cartland-Toledo Foundry Co., Toledo, O., will erect a new plant consisting of two buildings, 43 x 100 feet and 80 x 85 feet, respectively. The contract for the erection of the buildings was awarded to the M. Rabbitt & Sons Co.

The Blount Plow Works, Evansville, Ind., is having plans prepared for ten buildings including a foundry, at a cost of approximately $200,000.

The Fulton Iron Works, St. Louis, will erect a 150-foot addition to its machine shop and foundry and an office building also will be constructed.

The Modern Iron Works, Quincy, Ill., is making extensive changes to provide additional space for its cleaning department and sand and coke storage.

The Federal Malleable Iron Co., West Allis, Wis., will erect an addition to its plant. The Thomas S. Watson Co., Milwaukee, is consulting engineer.

The A. J. Detloff Co., Detroit, manufacturer of automobile parts is erecting a 3-story addition to its plant which will contain a brass and aluminum foundry.

The Hammond Malleable Iron Co., Hammond, Ind., will build two additions to its plant, one to be used for storage purposes and the other as a core room.

P. Kennedy's foundry, Baltimore, will be enlarged by the addition of a 3-story core and pattern shop which will provide 24,000 square feet of additional floor space.

The Milwaukee Die Casting Co., Milwaukee, Wis., is erecting a 2-story building 50 x 60 feet. A specialty will be made of white metal and aluminum die castings.

William Shimer Son & Co., Freemansburg, Pa., manufacturers of light hardware will erect three 2-story buildings, 75 x 242, 75 x 100 and 60 x 75 feet, respectively.

The Crompton & Knowles Loom Works, Worcester, Mass., is erecting an addition to its foundry and the second floor of this extension will be devoted to bench molding. A part of the equipment is being removed to a plant across the street from the present shop.

The Overland Shoe Co., Racine, Wis., is erecting a plant consisting of two buildings, 30 x 40 feet, two stories high and an aluminum foundry, 28 x 40 feet. In addition to manufacturing workmen's shoes provided with aluminum soles, aluminum castings for the jobbing trade also will be made.

The Valley Mold & Iron Co., Sharpsville, Pa., will erect two 2-story buildings, one 75 x 350 feet to be used for casting ingot molds and the other, 75 x 150 feet, which will be a ladle cleaning and repair building. These two buildings will be erected by the Penn Bridge Co., Beaver Falls, Pa., and the third building will be constructed by the McMyler-Interstate Co., Cleveland. Six electric traveling cranes will be installed by the Morgan Engineering Co., Alliance, O.

The Graf Stove & Range Co. has obtained a site at Silver Lake, Wis., for the erection of a new plant and upon its completion, early in October, the company will remove its equipment from its plant at Louisville, Ky. The plant at Silver Lake, Wis., will consist of two buildings, each 100 x 80 feet, the foundry being located in one, while the other will be devoted to stove manufacture and also will contain the warehouse. The site is on the Chicago & North-Western and the Soo Line railroads.